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**ASARCO LLC - Hayden Operations  
Hayden, Arizona**

**Acid Plant Tail Gas  
Particulate Emissions  
Test Report**

**Air Quality Permit No. 1000042 & Minor Permit Revision No. 54251  
Consent Decree No. CV-15-02206-PHX-DLR**

**Test Dates: 12/19,20/16**

**By:**

**Energy and Environmental Measurement Corporation (EEMC)**

**3730 N. Pellegrino Drive, Tucson, Arizona 85749  
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[EEMCorp@comcast.net](mailto:EEMCorp@comcast.net)**

**1744 Mullowney Lane, Billings, Montana 59101  
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# REVIEW AND CERTIFICATION



## By EEMC Personnel:

All work, calculations, other activities, tasks performed and documented in this report were carried out under my (Team Leader/QSTI) direction and supervision. This test project conforms to EEMC's Quality Manual and to the requirements of ASTM D-7036.

A handwritten signature in blue ink, appearing to read "Matthew Nurimba".

Date 11/4/17

Matthew Nurimba  
Environmental Project Manager

I have reviewed all testing details, calculations, results, conclusions and other appropriate written material contained herein, and hereby certify that the presented material is authentic and accurate.

A handwritten signature in blue ink, appearing to read "Ed Wadington".

Date 1/6/17

Ed Wadinton  
Executive Manager, EEMC

## By Company Personnel:

I have reviewed the information being submitted in its entirety and based on information and belief formed after reasonable inquiry, I certify that the statements and information contained in this submittal are true, accurate, and complete.

Date \_\_\_\_\_

Signature \_\_\_\_\_

Name (Printed) \_\_\_\_\_

Title \_\_\_\_\_

Company \_\_\_\_\_

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## FIELD OBSERVATION SHEET

**Test Dates:** **12/19,20/16**

**Plant Name:** **ASARCO Hayden Operations - Hayden Smelter**

**Plant Address:** **Smelter Address:** **6094 N. Asarco Road**  
**Hayden, Arizona 85135**      **Mailing Address:** **P.O. Box 8**  
**Hayden, Arizona 85135**

**Source Tested:** **Acid Plant Tail Gas**

**Plant Contacts:** **Jack Garrity - Technical Services Manager**  
**Phone:** **(520) 356-3284**  
**Phone:** **Amy Veek, Environmental Engineer**  
**Email:** **Aveek@asarco.com**  
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**Observers and Affiliation:** **Amy Veek - ASARCO Hayden**

**EEMC Field Team:**  
**Team Leader:** **Matt Nurimba, QSTI**  
**Instrumentation:** **Matt Nurimba**  
**Meterbox:** **George Wilson, QSTI**  
**Stack/Sample Recovery:** **Joanne Sufi, QSTI/John Bustin**

**Data Analysis:** **Joanne Sufi, Ed Wadington**  
**Report Preparation:** **Joanne Sufi**

### **Energy and Environmental Measurement Corporation (EEMC)**

**3730 N. Pellegrino Drive, Tucson, Arizona 85749**  
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**EEMCorp@comcast.net**

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## INTRODUCTION

ASARCO LLC - Hayden Operations contracted with Energy and Environmental Measurement Corporation (EEMC) to conduct a series of emissions evaluations on the Acid Plant Tail Gas located in Hayden, Arizona. The purpose of this report is to outline the sampling and analytical methods employed (as described in the test protocol dated 07/21/16), report field/laboratory data and provide test results.

## TEST CHRONOLOG

Date/Time	Run	Location	Test Description(s)
<b><u>12/19/16</u></b>			
12:48-17:05	1-PT	Acid Plant Tail Gas	EPA Methods 1-5b
<b><u>12/20/16</u></b>			
08:28-13:29*	2-PT	Acid Plant Tail Gas	EPA Methods 1-5b
14:14-18:25	3-PT	Acid Plant Tail Gas	EPA Methods 1-5b

\*Run interrupted and resumed several times: 08:28-08:31, 08:50-08:51, 08:57-09:00, 09:12-09:15, 09:24-13:29

## PROCESS EQUIPMENT/DATA DESCRIPTION

### Equipment Description

#### Inco Flash Furnace and Fluid Bed Dryers Operations

Wet feed is conveyed by variable speed belt feeders to two natural gas fired fluid bed dryers. The dried concentrate is carried along as particulate with the exhaust gases from the top of the dryers to the product baghouses, where it is recovered from the air stream and dropped onto screw conveyors. The screw conveyors transport the dried concentrate feed into the dry feed bins. The dry feed flows by gravity to the Inco oxygen flash furnace where it is introduced into one of four burners and combined with combustion oxygen. The resulting molten bath in the flash furnace separates into a heavy matte layer and a lighter slag layer. The matte is tapped into ventilated launders which empty into 17 – 20 ton ladles. The filled ladles are then transported by rail, beneath the flash furnace to the converter aisle floor. The lighter slag is skimmed from the molten bath into a pot. The slag hauler picks up each slag filled pot and empties them onto the slag dump. The product baghouses ventilation gases and matte tapping/slag skimming ventilation gases are directed to an electrostatic precipitator (ESP) for particulate matter control before exiting the annulus of the 1000' stack. The flash furnace primary ventilation gases are routed to the gas cleaning plant for particulate removal and then to the acid plant for SO<sub>2</sub> control.

#### Converter Operations

The converters receive matte, which is approximately 50 – 60% copper, from the Inco flash furnace. The converter department is comprised of five Peirce Smith converters. After matte charging is complete, the converter is blown with air or oxygen enriched air which removes sulfur from the matte by converting it to sulfur dioxide. The off gases from blowing are collected in the converter primary ventilation system and routed to the gas cleaning plant for particulate removal and then to the acid plant for SO<sub>2</sub> control.

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## **PROCESS EQUIPMENT/DATA DESCRIPTION- continued**

### Converter Operations - continued

Normal converter department operation consists of one to two converters blowing and a third converter hot. The air or oxygen enriched air is blown into the molten bath through tuyeres located in the back of the converter below the surface of the molten bath. After the first slag blowing cycle, slag is skimmed from the bath and additional matte and some flux are added to the converter. This is followed by a second slag blowing. Scrap copper and reverts are added to regulate the temperature in the converters. The skimming of slag (which is returned to the Inco flash furnace) and addition of matte and other reagents are considered secondary operations and are typically collected in the converter secondary hood ventilation system. The gases collected in the secondary ventilation system are routed to the secondary hood baghouse for particulate control before exiting the annulus of the 1000' stack. The final converter product is called blister copper which is approximately 96 to 98% pure copper. Molten blister copper from the converters is poured into ladles which are then transferred by bridge crane to one of the three anode furnaces located at the northern end of the converter aisle.

### Acid Plant Operations

The primary ventilation gases from the flash furnace and converters are first routed to the gas cleaning plant prior to entering the acid plant. The primary ventilation gases are cleaned of particulate matter via a series of process scrubbers and electrostatic precipitators. Once the gases are cleaned of particulates, they are routed to a double contact acid plant designed to remove SO<sub>2</sub> through the production of sulfuric acid. The sulfuric acid production process consists of three principle steps:

1. Drying of the sulfur dioxide gas from the gas cleaning system.
2. Conversion of sulfur dioxide gas to sulfur trioxide gas.
3. Absorption of the sulfur trioxide gas in sulfuric acid.

A product pump and a cooler are provided to allow production of 93% and 98% sulfuric acid which is pumped to eight storage tanks. The acid plant tail gases exit through the inner main stack of the 1000' stack.

### Acid Plant

- A. Process Equipment Controlled: Flash Furnace and Converters
- B. Gas Conditioning Prior to Control Equipment: Gases are cleaned of particulate matter via wet scrubbers and electrostatic precipitators prior to entering the acid plant.
- C. Process Equipment Monitoring Parameters:
  - a. Flash Furnace - Burner feed rate (recorded every minute)
  - b. Converters - Air flow rate through each converter and number of converters blowing (recorded every minute)
- D. Maximum Process Equipment Operating Rates to be tested at:
  - a. Flash Furnace  
Burner feed rate: 75 - 100 tons per hour (3 - 4 burners)
  - b. Converters  
Number of Converters Blowing: 1 - 2

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## **PROCESS EQUIPMENT/DATA DESCRIPTION- continued**

### **Process Data Monitoring**

#### **Acid Plant**

- A. Description of Control Equipment / Specifications:
  - a. Manufacturer: Monsanto
  - b. Capacity: 2,800 TPD
  - c. Volume: 120,000 SCFM
  - d. Max. SO<sub>2</sub> Inlet: 12%
  - e. Performance: 650 ppm SO<sub>2</sub> maximum averaged over 6 hours
- B. Parameters to be Monitored during Testing (recorded every minute):
  - a. Acid Flow over the Interpass Tower
  - b. Acid Flow over the Final Tower

## **TEST PROCEDURES**

Schematics of the sampling trains are included in the Test Methods section as tabulated.

#### **Particulate Emission Tests**

EPA Methods 1-4 and 5b<sup>[1]</sup> were employed for determination of stack flue gas particulate concentration and mass loss.

The sample train was a modified method 5 train, consisting of a glass button-hook nozzle followed by a heated SS pitobe assembly (S-type pitot tube and a Type K thermocouple) leading to a heated EPA Type A glass fiber filter ( $\sim 325 \pm 25$  °F). The filtered gases were pulled through four Greenberg-Smith impingers (1 and 2 and 3 - 100 ml H<sub>2</sub>O<sub>2</sub>, 4-empty, 5-silica gel). The H<sub>2</sub>O<sub>2</sub> was placed in the impingers to prevent any SO<sub>2</sub> from reaching the meter box. The filtered and dried gases were then pulled, via an umbilical cord, to a dry gas meter box for gas volume metering. Each test duration was four hours.

Upon completion of the test run, moisture was determined by gravimetric analysis of the impinger liquid gain. Resultant particulate samples were recovered from the train according to the methods. The particulate filter capture was heated at 320°F for six hours prior to weighing. Particulate samples were analyzed at the EEMC Tucson laboratory. Laboratory results are included in the Field Data and Calculations section.

#### **Gas Volume**

EPA Methods 1-4<sup>[1]</sup> were employed for determination of the stack gas velocity, density and moisture content. The described methods were employed to produce both the concentration and mass flow.

#### **O<sub>2</sub> Emissions**

EPA Method 3A<sup>[1]</sup> was employed for determination of stack gas O<sub>2</sub> concentration. The stack gases were extracted from the stream and conveyed to a Servomex 1400 Oxygen analyzer. EPA Protocol 1 calibration gases were utilized for instrument span checks. Zero was checked with zero N<sub>2</sub> gas. Results were recorded via an integrating/computer logger on a one-minute basis. A full span of 0-20.99 %vd O<sub>2</sub> was utilized.

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## TEST PROCEDURES - continued

### CO<sub>2</sub> Emissions

EPA Method 3A<sup>[1]</sup> was employed for determination of stack gas CO<sub>2</sub> concentration. The stack gases were extracted from the stream and conveyed to a Servomex 1440 CO<sub>2</sub> analyzer. EPA Protocol 1 calibration gases were utilized for instrument span checks. Zero was checked with zero N<sub>2</sub> gas. Results were recorded via an integrating/computer logger on a one-minute basis. A full span of 0-19.49 %vd CO<sub>2</sub> was utilized.

## UNITS OF REPORTING

The data is reported with the following units:

- 1) Particulates
  - gr/dscf - grains per dry standard\* cubic foot (\*@ 68 °F and 29.92 "Hg)
  - mg/dscm - milligrams per dry standard\* cubic meter (\*68 °F and 29.92 "Hg)
  - lb/hr - pounds per hour
- 2) CO<sub>2</sub>/O<sub>2</sub>
  - %vd - percent of a volume basis without moisture
- 3) Gas Stream Characteristics
  - AWCFM - actual wet cubic feet per minute
  - DSCFH - standard\* dry cubic feet per hour (\*@ 68 °F and 29.92 "Hg)
  - Temperature - °F - degrees Fahrenheit
  - Moisture - %H<sub>2</sub>O v/v - percent moisture on a volume basis

## RESULTS

This report contains summarizations of all pertinent sampling and analytical results. Field and laboratory data is included as tabulated. Example calculations are included in the field data section. No process, environmental or test conditions were observed that would have affected the test results.

## REFERENCES

- <sup>[1]</sup> 40CFR60, App. A, Methods 1-4 and 5b, 2015

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## COMPLIANCE STATEMENT

**ASARCO Hayden Operations - Hayden Smelter  
Hayden, Arizona  
Acid Plant**

**Emission Limit:**

Consent Decree No. CV-15-02206-PHX-DLR

P. 24

IV. Compliance Requirements

16. Acid Plant PM Emission Limit

Gas discharged from the acid plant shall not contain non-sulfuric acid PM  
in excess of 6.2 mg/dscm

**Measured Emissions (12/19-20/16):**

1.20 mg/dscm              PASS

**Summary of ASARCO LLC Hayden Operations****Particulate Emission Data****Hayden Smelter - Acid Plant (S2)****12/19-20/16**

EPA Method 5b Particulates				
Run	Time	gr/dscf	lb/hr	mg/dscm
1-PT	12:48-17:05	0.0006	0.46	1.31
2-PT	08:28-13:29*	0.0004	0.35	0.92
3-PT	14:14-18:25	0.0006	0.52	1.37
<b>Mean</b>		<b>0.0005</b>	<b>0.44</b>	<b>1.20</b>

EPA Methods 1-4 GAS STREAM CHARACTERISTICS								
Run	Time	AWCFM	ADCFM	DSCFH	Ts °F	H <sub>2</sub> O	CO <sub>2</sub>	O <sub>2</sub>
						%v	%vd	
1-PT	12:48-17:05	143,988.2	143,887.4	5,685,810.0	291.6	0.07	0.28	13.94
2-PT	08:28-13:29*	154,643.5	154,597.1	6,187,556.0	282.8	0.03	0.30	14.89
3-PT	14:14-18:25	151,563.2	151,563.2	6,012,623.3	285.7	0.00	0.29	15.53
<b>Mean</b>		<b>150,065.0</b>	<b>150,015.9</b>	<b>5,961,996.4</b>	<b>286.7</b>	<b>0.03</b>	<b>0.29</b>	<b>14.79</b>

\* Run Interrupted and Resumed: 08:28-08:31, 08:50-08:51, 08:57-09:00, 09:12-09:15, 09:24-13:29

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**IN THE UNITED STATES DISTRICT COURT**  
**FOR THE DISTRICT OF ARIZONA**  
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7  
8

9 United States of America,

No. CV-15-02206-PHX-DLR

10 Plaintiff,

**CONSENT DECREE**

11 v.

12 ASARCO LLC,

13 Defendant.  
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1 needs in relation to other types of continuous emission monitors cannot be resolved  
 2 through reasonable expenditures of resources. If EPA approves ASARCO's  
 3 demonstration that it is infeasible to continue operating a PM CEMS, ASARCO shall not  
 4 be subject to stipulated penalties for exceedances of PM emission limits based on data  
 5 recorded by that PM CEMS during (a) the time in which the PM CEMS' operation was  
 6 infeasible (including any period of time that occurred prior to submittal of the  
 7 demonstration), (b) the pendency of EPA's review of ASARCO's demonstration or  
 8 alternative PM monitoring plan, and (c) the pendency of any proceeding undertaken  
 9 pursuant to Section XIII (Dispute Resolution). If EPA determines that operation is  
 10 infeasible, ASARCO shall be entitled to discontinue operation of and remove the PM  
 11 CEMS. At that point, ASARCO shall comply with the approved alternative PM  
 12 monitoring plan.

13         16. Acid Plant PM Emission Limit. Process off-gas discharged from the  
 14 smelting flash furnace shall be routed to the acid plant. ASARCO shall operate a  
 15 continuous opacity monitoring system (COMS) on the exhaust stream from the acid plant  
 16 and, within 90 days of the Date of Lodging, shall submit to EPA for review and approval  
 17 proposed corrective action triggers based on COMS readings. Gas discharged from the  
 18 acid plant shall not contain non-sulfuric acid PM in excess of 6.2 mg/dscm. Prior to  
 19 installation and certification of a PM CEMS for this gas stream, compliance with the 6.2  
 20 mg/dscm limit shall be determined using the test methods specified in 40 C.F.R. §  
 21 63.1450(b), to be performed at least once each three hundred sixty-five (365) days  
 22 following the Effective Date, until one of the following:

- 23             a. Upon installation and certification of a PM CEMS for this gas  
 24 stream, compliance shall be determined on the basis of an eight (8) hour rolling average  
 25 limit, including periods of startup, shutdown, and malfunction; or
- 26             b. If PM CEMS certification fails for this gas stream, upon EPA  
 27 approval, ASARCO shall begin complying with an alternative PM monitoring plan.

28         ///

Governor Jane Dee Hull

State of Arizona

Jacqueline E. Schafer, Director

Arizona Department of Environmental Quality



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## ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY AIR QUALITY CLASS I PERMIT

**COMPANY NAME:** ASARCO Incorporated  
**FACILITY NAME:** Ray Complex Hayden Smelter  
**PERMIT NUMBER:** 1000042  
**DATE ISSUED:** October 9, 2001  
**EXPIRY DATE:** October 9, 2006

### SUMMARY

This operating permit is issued to ASARCO Incorporated, the Permittee, for operation of their Ray Complex Hayden Smelter, located in Hayden, Gila County, Arizona. The Hayden Smelter is a primary copper smelter and consists of one Inco oxygen flash furnace, five Pierce-Smith converters, two Fuller anode furnaces, two Fuller fluid bed dryers and other auxiliary operations.

In regard to air pollution control, the Hayden Smelter operates a double contact acid plant, the Monsanto sulfuric acid plant to remove sulfur dioxide ( $\text{SO}_2$ ) from the flash furnace and converters primary gases. The smelter also operates an electrostatic precipitator, the R&R Cottrell ESP for particulate matter (PM) removal from the flash furnace vent gases and the dryers flue gases, and a baghouse to capture the converters secondary hooding particulates. Baghouses are also used in other processes to control PM emissions.

The Hayden Smelter is classified as a Class I, Major Source, pursuant to A.A.C. R18-2-101.61. The potential emission rates of the following pollutants are greater than 100 tons per year: (i) particulate matter, (ii) sulfur dioxide, and (iii) nitrogen oxides.

This Class I permit is issued in accordance with Title V of the Clean Air Act, and Title 49, Chapter 3 of the Arizona Revised Statutes. Applicable requirements for the operations at Hayden are listed in portions subtitled "Permit shield" of this permit. All definitions, terms, and conditions used in this permit conform to those in the Arizona Administrative Code R18-2-101 et. seq. (A.A.C.) and 40 Code of Federal Regulations (CFR), except as otherwise defined in this permit. Unless noted otherwise, references cited in the permit conditions refer to the A.A.C. All terms and conditions in this permit are enforceable by the Administrator of the United States Environmental Protection Agency (U.S. EPA), except for those terms and conditions that have been designated as "State requirements".

5. Permittee may submit, for purposes of compliance with an opacity standard in this section, COMS data results produced during any performance test required under this section in lieu of the Method 9 observation data. Permittee using a COMS for compliance purposes is responsible for demonstrating that the COMS meets the requirements specified in 40 CFR 60.13(c), that the COMS has been properly maintained and operated, and that the resulting data have not been altered in any way.

[40 CFR 60.11(e)(5)]

6. Permittee shall maintain and operate any affected facilities of this section, including associated air pollution control equipment, in accordance with the particular requirements specified under subsection II.C, "Air Pollution Control Requirements". Determination of whether acceptable operating and maintenance procedures are being used for these facilities shall be based on information available to the Director which may include, but is not limited to, monitoring results, opacity observations, review of operating and maintenance procedures, and inspection of the source.

[40 CFR 60.11(d)]

7. For the purpose of submitting compliance certifications or establishing whether or not Permittee has violated or is in violation of any standard in this section, nothing in this section shall preclude the use, including the exclusive use, of any credible evidence or information, relevant to whether a source would have been in compliance with such standards if the appropriate performance or compliance test or procedure had been performed.

[40 CFR 60.11(g)]

## B. Emission limits and Standards

### 1. Furnace/Dryers Visible Emissions Standard

At all times except for periods of startup, shutdown, and malfunction as defined in paragraphs II.A.2.a,b and c of this Section, Permittee shall not cause to be discharged into the atmosphere from the furnace and/or any dryers of this section, any visible emissions which exhibit greater than 20 percent opacity. Opacity readings of portions of plumes which contain condensed, uncombined water vapor shall not be used for purposes of determining compliance with the opacity standard.

[40 CFR 60.164(a) and (b), 60.11(c) and 60.11(e)(1)]

### → 2. Dryers Particulate Matter Standard

Permittee shall not cause to be discharged into the atmosphere from any dryer of this section any gases which contain particulate matter in excess of 50 mg/dscm (0.022 gr/dscf). Emissions in excess of the level of the applicable emission limit during periods of startup, shutdown, and malfunction shall not be considered a violation of the applicable emission limit.

[40 CFR 60.8(c) and 60.162(a)]

### 3. Furnace Sulfur Dioxide Standard

Permittee shall not cause to be discharged into the atmosphere from the Inco oxygen flash furnace any gases which contain sulfur dioxide in excess of 0.065 percent by volume. Emissions in excess of the level of the applicable emission limit during periods of startup, shutdown, and malfunction shall not be considered a violation of the applicable emission limit.

[40 CFR 60.8(c) and 60.163(a)]

## C. Air Pollution Control Requirements

### 1. Particulate Matter Control for Dryers

[40 CFR 60.11(d)]

Permittee shall operate the R&R Cottrell ESP. At all times, including periods of startup, shutdown, and malfunction, Permittee shall, to the extent practicable, continue to operate and maintain the two Fuller fluid bed dryers, their product baghouses and the R&R Cottrell ESP in a manner consistent with good air pollution control practice for minimizing particulate matter emissions.

- (1) Permittee name and address.
  - (2) Identification and location of monitors in the CEMS.
  - (3) Manufacturer and model number of each monitor in the CEMS.
  - (4) Assessment of CEMS data accuracy and date of assessment as determined by a relative accuracy test audit (RATA), relative accuracy audit (RAA), or cylinder gas audit (CGA) required under subsection II.E.3 including the relative accuracy for the RATA, accuracy of the CEMS for the RAA or CGA, reference method results, cylinder gases certified values, CEMS responses, and calculations results as defined in 40 CFR Part 60, Appendix F, Section 6. If the accuracy audit results show the CEMS to be out-of-control as described in paragraph II.D.2.f(5), Permittee shall report both the audit results showing the CEMS to be out-of-control and the results of the audit following corrective action showing the CEMS to be operating within specifications.
  - (5) Results from EPA performance audit samples and the applicable reference methods.
  - (6) Summary of all corrective actions taken when CEMS was determined out-of-control, as described in paragraphs II.D.2.f(2)(c) and II.D.2.f(5).
- e. Permittee shall log in ink or electronic format and maintain a record of 24-hour opacity measurements performed in accordance with II.D.3 and corrective actions taken, if any. A record of corrective actions taken shall include the date and time during which the 24-hour rolling average opacity exceeded 15 percent and the date, time and type of the corrective actions. [A.A.C. R18-2-306.A.3.c]
- f. Emission deviations reporting requirements

In addition to the quarterly reporting required under subsection II.D.4.d of this section, Permittee shall report emissions exceeding an emission limitation or standard as deviations in accordance with Section XI.B of Attachment "A" of this permit. [A.A.C. R18-2-306.A.5.b]

## E. Performance Testing Requirements

### 1. Furnace/Dryers Opacity Observation

Permittee shall perform an annual opacity observation of emissions from the Inco oxygen flash furnace and Nos. 1 and 2 fluid bed dryers in accordance with EPA Reference Method 9 to determine compliance with the visible emission standard of 20 percent opacity specified in paragraph II.B.1. [40 CFR 60.166(b)(3)]

### → 2. Dryers Particulate Matter Emissions Testing

Permittee shall determine compliance with the dryer particulate matter standard of 0.022 gr/dscf in paragraph II.B.2, using EPA Reference Method 5 testing annually at R&R flue to determine the particulate matter concentration. The sampling time and sample volume for each run shall be at least 60 minutes and 0.85 dscm (30 dscf). [40 CFR 60.166(b)(1)]

### 3. SO<sub>2</sub> CEMS Auditing

Permittee shall conduct audits for the SO<sub>2</sub> CEMS of paragraph II.D.2.a, at least once each calendar quarter. Successive quarterly audits shall occur no closer than 2 months. The audits shall be conducted as follows: [A.A.C. R18-2-312.H.3, 40 CFR 60.166(b) and 40 CFR 60, Appendix F.5.1]

#### a. Relative accuracy test audit (RATA)

[40 CFR 60.165(b)(2)(ii) and Appendix F.5.1.1]

## **IV. MORE REQUIREMENTS FOR FURNACE AND CONVERTERS OPERATION**

### **A. Applicability**

The requirements of this section are applicable to the following process sources: the Inco oxygen flash furnace and Nos. 1-5 Pierce Smith converters.

### **B. Emission limits and Standards**

#### **1. Opacity Standard**

Permittee shall not cause, allow or permit to be emitted into the atmosphere any plume or effluent from operation of any converters and/or the portion of furnace not associated with the Monsanto sulfuric acid plant, the opacity of which exceeds 20 percent. Where the presence of uncombined water is the only reason for the exceedance of the visible emissions requirement, such exceedance shall not constitute a violation.  
[A.A.C. R18-2-702(C) and 715(D)]

#### **2. Furnace Particulate Matter Standard [40 CFR 52.126(b) and A.A.C. R18-2-701(23), 701(24), 702(E) and 715(A)]**

Permittee shall not cause, allow or permit the discharge of particulate matter into the atmosphere from the furnace operation in total quantities in excess of the amount calculated by one of the following equations and rounded off to two decimal places:

- a. For the furnace operation having a process weight rate of 60,000 pounds per hour (30 tons per hour) or less, the maximum allowable emissions from the furnace shall be determined by the following equation:

$$E_f = 3.59 P_f^{0.62}$$

Where

$E_f$  = Furnace maximum allowable particulate emissions rate in pounds-mass per hour.

$P_f$  = Total furnace process weight rate in tons-mass per hour, which is the total weight rate of all materials introduced into the Inco oxygen flash furnace, including fuels, where these contribute to generation of particulate matters. It shall be the total process weight for the entire period of continuous operation or for a typical portion thereof, divided by the number of hours of such period or portion thereof.

- b. For the furnace operation having a process weight rate greater than 60,000 pounds per hour (30 tons per hour), the maximum allowable emissions from the furnace shall be determined by the following equation:

$$E_f = 17.31 P_f^{0.16}$$

Where " $E_f$ " and " $P_f$ " are defined as indicated in IV.B.2.a.

#### **3. Converter Particulate Matter Standard**

[40 CFR 52.126(b) and A.A.C. R18-2-701(23), 701(24), 702(E), 715(C) and 715(A)]

Permittee shall not cause, allow or permit the discharge of particulate matter into the atmosphere from all the converters in operation in total quantities in excess of the amount calculated by one of the following equations and rounded off to two decimal places:

- a. For the converters operation having a process weight rate of 60,000 pounds per hour (30 tons per hour) or less, the maximum allowable emissions from all the converters in operation shall be

determined by the following equation:

$$E_c = 3.59 P_c^{0.62}$$

Where

$E_c$  = Maximum allowable particulate emissions rate of all the converters in operation in pounds-mass per hour.

$P_c$  = Total converters process weight rate in tons-mass per hour, which is the total weight rate of all materials introduced into all the converters in operation, including fuels, where these contribute to generation of particulate matters. The process weight for each converter shall be the total process weight for a period which covers a complete operation or an integral number of cycles, divided by the hours of actual process operation during such period. In addition, for purposes of this section, the total process weight from all similar units employing a similar type process shall be used in determining the maximum allowable emission of particulate matter for that process.

- b. For the converters operation having a process weight rate greater than 60,000 pounds per hour (30 tons per hour), the maximum allowable emissions from all the converters in operation shall be determined by the following equation:

$$E_c = 17.31 P_c^{0.16}$$

Where " $E_c$ " and " $P_c$ " are defined as indicated in IV.B.3.a.

### C. Air Pollution Control Requirements

#### 1. Particulate Matter Control for Flash Furnace Vent Gas

Permittee shall operate the R&R Cottrell ESPs to treat all captured fugitive gases from matte tapping and slag skimming stations at the flash furnace for particulate matter removal prior to discharge to the atmosphere. [Installation Permit No. 1166, Condition 7]

#### 2. Particulate Matter Control for Secondary Hoods Vent Gas

Permittee shall operate and maintain the converter secondary hoods baghouse to minimize particulate emissions from the secondary hoods. [A.A.C. R18-2-317 Change to Operating Permit No. 0308-85]

### D. Monitoring, Recordkeeping and Reporting Requirements

#### 1. Converter Secondary Hoods Baghouse COMS

[A.A.C. R18-2-306.A.3.c]

- a. Unless the alternative methods and procedures as provided in subsection IV.D.4 below are implemented, Permittee shall, within 180 days from the effective date of this permit, install, calibrate, maintain, and operate a COMS downstream of the converter secondary hoods baghouse to monitor the baghouse outlet flue gas opacity.
- b. The converter secondary hoods baghouse COMS shall comply with the same performance, quality assurance, recordkeeping, and reporting requirements as specified in II.D.1 and 4 of this attachment for the R&R Cottrell ESP COMS.

2. Permittee shall weigh the material entering the Inco flash furnace with a weightometer and shall count the number of ladles carrying material to the converters to determine the process weight rates in tons-mass per hour to the furnace and converters. [A.A.C. R18-2-306.A.3.c]

- c. If the bag leak detection system alarms, Permittee shall initiate investigation of the secondary hoods baghouse within 24 hours of the first discovery of the alarming incident and, if necessary, take corrective action as soon as practicable to adjust or repair the baghouse to minimize possible exceedances of the particulate standard established in paragraphs IV.B.3 of this section.

[A.A.C. R18-2-306.A.3.c]

- d. Permittee shall log in ink or electronic format and maintain a record of installation, calibration, maintenance, and operation of the bag leak detection system in accordance with Section XII, Attachment "A" of this permit. In the case of any alarming incident, the record shall include an identification of the date and time of all bag leak detection alarms, their cause, and an explanation of the corrective actions taken, if any.

[A.A.C. R18-2-306.A.3.c]

→ **E. Performance Testing Requirements**

[A.A.C. R18-2-715(E)]

**1. Performance Testing Methods and Frequency**

Permittee shall conduct performance tests at least once every year with the following reference methods to determine compliance with the particulate matter emissions standard set forth in IV.B.2 and 3 of this section for the one-thousand-foot stack:

- a. Reference Method 1 for sample and velocity traverses;
- b. Reference Method 2 for volumetric flow rate;
- c. Reference Method 3 for gas analysis;
- d. Arizona Testing Method A1 or Reference Method 5 for concentration of particulate matter and associated moisture content.

**2. Sampling Location**

The performance tests shall be conducted at and samples be withdrawn contemporaneously from the following locations:

- a. R&R ESP outlet flue;
- b. Secondary Hoods Baghouse outlet flue; and
- c. Monsanto Acid Plant outlet flue.

**3. Compliance Demonstration**

Permittee shall demonstrate compliance by comparing the sum total of all emissions from each sampling location as determined under IV.E.1 and 2 above with the sum total of all the maximum allowable particulate emissions rates set forth in IV.B.2 and 3.

**F. Permit Shield**

Compliance with the terms of this section shall be deemed compliance with the following applicable requirement(s) in effect on the date of permit issuance: 40 CFR 52.126(b), A.A.C. R18-2-715.A, A.A.C. R18-2-715.C, A.A.C. R18-2-715.D, A.A.C. R18-2-715.E, and Installation Permit No. 1166, Condition 7.

**V. CONVERTERS ARSENIC CHARGING RATE MONITORING**

**A. General Provisions of the Section**

1. The requirements of this section apply to any copper converter under this permit where the total arsenic charging rate for the copper converter department averaged over a 1-year period is less than 75 kg/hr.

**MINOR PERMIT REVISION NO. 54251  
TO  
AIR QUALITY PERMIT NO. 1000042  
ASARCO-HAYDEN SMELTER**

**MINOR PERMIT REVISION DESCRIPTION**

This Minor Permit Revision to Operating Permit No.1000042 authorizes ASARCO to install and operate a spray tower and a baghouse to control particulate matter emissions from the anode furnaces.

**ATTATCHMENT "B"**

The following Section XV shall be added to the Permit No. 1000042

**XV. ANODE FURNACES**

**A. Applicability**

The requirements of this Section are applicable to the Anode Furnaces #0, #1 and #2.

**B. Particulate Matter and Opacity**

→ 1. Emissions Limitations and Standards

- a. The Permittee shall not cause, allow or permit the discharge of particulate matter into the atmosphere in any one hour from the stack of anode furnace baghouse in excess of the amounts determined by the following equations:  
[A.A.C. R18-2-715.A.1]

$$E = 4.10P^{0.67}$$

where:

E= The maximum allowable particulate emissions rate in pounds-mass per hour.

P= The process weight rate in tons-mass per hour. For purposes of this section, the total process weight from all similar units employing a similar type process shall be used in determining the maximum allowable emission of particulate matter.

- b. The total process weight from all similar units employing a similar type process shall be used in determining the maximum allowable emission of particulate matter for that process.  
[A.A.C. R18-2-715.D]

- c. Following a reasonable period not exceeding 180 days after the installation of anode furnace baghouse, the Permittee shall not cause to be discharged into the atmosphere from the stack of the baghouse any gases which contain particulate matter in excess of 0.003 grain per standard cubic foot (gr/scf).  
[A.A.C R18-2-306.A.2]

- d. The Permittee shall not cause, allow or permit to be emitted into the atmosphere any plume or effluent from the stack of anode furnaces bag house, the opacity of which exceeds 20 percent, as determined by Reference

improvement plan required pursuant to Condition XV.B.3.d(5) of this Attachment and any activities undertaken to implement a quality improvement plan, and other supporting information required to be maintained under this Section (such as data used to document the adequacy of monitoring, or records of monitoring, maintenance or corrective actions).

- (iv) Instead of paper records, the Permittee may maintain records on alternative media, such as microfilm, computer files, magnetic tape disks, or microfiche, provided that the use of such alternative media allows for expeditious inspection and review, and does not conflict with other applicable recordkeeping requirements.

→ 4. Performance Testing Requirements

Within 180 days of the installation of the capture and control system for anode furnaces and once per operating permit term thereafter, the Permittee shall conduct performance test with the following reference methods:

- a. Reference Method 1 for sample and velocity traverses;
- b. Reference Method 2 for volumetric flow rate;
- c. Reference Method 3 for gas analysis; and
- d. Arizona Testing Method A1 or Reference Method 5 for concentration of particulate matter and associated moisture content.

The Permittee shall perform 3 test runs as per the procedure above, and use the average of the 3 test runs to demonstrate compliance with the emission standards in Conditions XV.B.1.a and XV.B.1.c.

## ATTACHMENT "C": EQUIPMENT LIST

**Air Quality Control Permit No. 1000042  
for  
ASARCO Incorporated Ray Complex - Hayden Smelter**

**Table C-1. Process and Control Equipment Description**

Equipment	Quantity	Manufacturer	Model/Type	Serial No.	Date Installed or modified	Size	Rated Capacity	New or Existing
<b>Sampling and Unloading Operations:</b>								
Dump hopper	1	Linkbelt	stainless steel lining	n/a	1983	12'x28.6'	175 tph, 1,533,000 tpy	Existing
Unloading conveyors	3	Linkbelt	n/a			60"x17'8"	175 tph, 1,533,000 tpy	Existing
Tripper car & belt separator	2	Linkbelt	5IM	n/a	1964/1968	cars: 30"x20'	175 tph, 1,533,000 tpy	Existing
Bedding area - 4 storage bins	4	Concrete	n/a	n/a	1964/1968	220'x40'x20'	30,000 wet tons, 26,000 dry tons	Existing
Bedding area - Vibrating screen/grizzly	1	Ty-rock	I-surface/F300	7308	1967	4' x 8'	n/a	Existing
Reclaim hopper & feeder	1	Feeder Belt, Rex Chainbelt Inc.	n/a	n/a	1968	Hopper: 20 cy Belt feeder: 42" wid. x 20' centers	150 tph, 1,533,000 tpy	Existing
No. 2 main inclined conveyor	1	n/a	50 HP motor	n/a	1982	24" width by 625' length	300 tph, 2,628,000 tpy	Existing
No. 3 inclined conveyor	1	Boston Dulton 600	3 -ply	n/a	1982	30" width by 439' length	300 tph, 2,628,000 tpy	Existing
Delumper at oxygen furnace charge system	1	Jeffrey Manufacturing Division	Jeffrey 5WR5 /Reversible impactor	13492	1982	n/a	300 tph, 2,628,000 tpy	Existing

Equipment	Quantity	Manufacturer	Model/Type	Serial No.	Date Installed or modified	Size	Rated Capacity	New or Existing
No. 4 Horizontal Conveyor	1	Boston Dulon 600	4-ply	n/a	1982	42" width by 139' length	300 tph, 2,628,000 tpy	Existing
<b>Flash Furnace Building Operations:</b>								
Wet bin conveyors, dryer feed & weigh belts	4	ASARCO design	n/a	n/a	1983	30" width	85 tph, 744,600 tpy	Existing
Hammer Mill	1	Pennsylvania Crusher Corporation	GRT#1	n/a	1983	42" x 12" x 31"	6tph, 52,560 tpy	Existing
Nos. 1 & 2 Fluid bed dryers with burners	2	Fuller	11-81-20337-106 Farrier natural gas burners	n/a	1983	11'3" diameter (ID shell) x 26' high	Production: 64 wet ton/hr, 560,640 tpy Burner firing gas: 38,000 CFH x 2 burners Burner firing oil: 270 gph x 2 burners Maximum dryer usage: 6,915 hours per year	New
Blow tank pneumatic conveyor (hammer mill feeds surge bin then material drops into line with air blown to dry dust bin)	1	Fuller/Abresist	n/a	n/a	1983	4"	4.2 tph, 36,792 tpy	Existing
Fluid bed dryer product baghouse Nos. 1 & 2	2	Peabody Process Systems, Inc.	PMTR-10-1692 TW Pulse	n/a	1982	n/a	Gas flow rate: 55,000 ACFM	New
Dry screw conveyors #1-8, furnace charge system	8	FMC	n/a	n/a	1983	16" and 9" width	56.9 tph, 498,444 tpy	Existing
Feed screw conveyors #10-16, furnace charge system	7	FMC	n/a	n/a	1983	12" width	n/a	Existing

Equipment	Quantity	Manufacturer	Model/Type	Serial No.	Date Installed or modified	Size	Rated Capacity	New or Existing
200-ton west wet bins nos. 1 & 2	2	n/a	n/a	n/a	1983	n/a	n/a	Existing
200-ton dry bins nos. 1 through 4, each served by one ventilation baghouse	4	DCE Vokes	DLM V10/10 F3 20 envelope filter bags	n/a	1983	Cloth area: 105 sq. ft.	1050 acfm	Existing
30-ton dust bin no. 1 served by a ventilation baghouse	1	BHA	4 Cartridge Filters	n/a	1998	Cloth area: 480 sq. ft.	1200 acfm	Existing
30-ton flux bin no. 3 served by a ventilation baghouse	1	Fuller	Pulse	n/a	1983	Cloth area: 166 sq. ft.	1200 acfm	Existing
Oxygen flash furnace with burner (smelter)	1	Inco	with oxygen burner	n/a	1983	24 ft. x 80 ft.	24,000 tpd concentrates When process is down, furnace is kept hot with up to 4 natural gas burners. Maximum gas usage is 91,113 CFH.	New
WGHS Venturi Scrubber	1	Swemco Inc.	SW-A-138696 Variable throat	14520	August, 1997	42" inlet diameter	flow rate 62,913 acfm	n/a
WGHS Disengagement vessel	1	Swemco Inc.	SW-A-138696	14525-100	August, 1997	5' diameter inlet	flow rate 62,913 acfm	n/a
WGHS Condensing Heat Exchanger	1	Fleck, Ltd.	95-336 Shell & tube	1781	1997	8' diameter vessel	80 MBtu/hr heat exchange	n/a
WGHS Saturation Tower	1	Structural Steel and Fabrication Company	Refractory lined wet tower	n/a	fourth quarter 1997	25' high x 8' dia.	125,168 acfm	n/a
WGHS Stripping Tower	1	Structural Steel and Fabrication Company	Disk and Do-nut	n/a	fourth quarter 1997	34' high x 3' dia.	1,032 acfm	n/a

Equipment	Quantity	Manufacturer	Model/Type	Serial No.	Date Installed or modified	Size	Rated Capacity	New or Existing
<b>Revert Crushing System:</b>								
Feeder	1	Kue-Ken	Hydro stroke feeder	270	1980	n/a	200 tph, 42,000 tpy	New
Jaw Crusher	1	Kue-Ken	n/a	11011781	1980	25' x 42'	200 tph, 42,000 tpy	New
Vibrating screen	1	Tyler Industry	R1204X	502626	1980	n/a	200 tph, 42,000 tpy	New
Cone crusher	1	Kue-Ken	n/a	3095132	1980	n/a	200 tph, 42,000 tpy	New
Belt conveyors	2	Kue-Ken	BC-203 and BC-206	n/a	1980	n/a	200 tph, 42,000 tpy	New
Revert crushing baghouse	1	Peabody Process Systems, Inc.	PMTR-10-592W pulse	01-5011-01	1989	6,974 sq. ft.	32,000 acfm	New
<b>Converter Building:</b>								
Converters	5	n/a	Pierce Smith Each converter has a natural gas burner to keep vessel heated during holding fire.	n/a	1969	one with 13'x35', one with 13'x30' and three with 13'x33'	100 tons copper per cycle 170 tons matte per cycle 40 tons cold dope per cycle Maximum gas usage: 17,695.8 CFHx1.5 converters	Existing
Converter silica conveying system	1	B.F. Goodrich for belts	Consists of three unloading hoppers with conveying belts	n/a	1968	24" belts 44.3' length	60 tph, 525,600 tpy	Existing
Converter primary hooding	5	ASARCO design	Steel	n/a	1999/2000	length 10.28 feet	n/a	Existing
Converter cyclones	10	Ducon	Model 1000 with high efficiency dyclones	n/a	1966 and 1968	1000	n/a	Existing
Converter spray chamber	1	ASARCO	Spray	n/a	1973	n/a	n/a	Existing

Equipment	Quantity	Manufacturer	Model/Type	Serial No.	Date Installed or modified	Size	Rated Capacity	New or Existing
Converter secondary hooding	1	ASARCO design	n/a	n/a	1979	n/a	n/a	Existing
Secondary hoods baghouse	1	Hosakawa Mikropul	1000 J-10-30-TRH pulse type	950281 H1-H7	1996	Seven modules with 11,780 sq. ft. per module	300,000 acfm total working volume, 0.1158 gr/dscf maximum dust loading, and 0.0861 gr/dscf inlet loading	n/a
<b>Gas Cleaning Plant:</b>								
Process gas precipitators	4	Chemiebau	Four train	n/a	1969	n/a	200,000 scfm	n/a
Gas Scrubbers	5	Rust Engineering	Open towers (3) and packed (2)	n/a	1961	n/a	n/a	n/a
Mist precipitators	8	ASARCO design	Mist wet ESP Gas flows through 4 parallel trains, each 2 units deep, thus 4 inlets and 4 outlets	n/a	1983	180 tubes 15 foot length	n/a	n/a
Gas cleaning plant pugmill	1	ASARCO	n/a	n/a	1967	n/a	n/a	n/a
<b>Acid Plant:</b>								
Acid plant	1	Monsanto	double contact	n/a	1983	n/a	2,820 STPD (100% acid basis) as 93% H <sub>2</sub> SO <sub>4</sub> using 12.4% SO <sub>2</sub> 24,703,200 STPY	n/a
Acid plant preheater	1	Thermal Transfer Corporation	Natural gas fired	n/a	1983	22.75'x8' O.D. shell	40,000 scfm of start up air 107,925 CFH max. fuel input	Existing
<b>Anode Plant:</b>								
Anode furnaces #1 & #2 with burners, Anode furnace #3 with burners (spare)	3	n/a	Fuller Co. Natural gas fired	n/a	1971	13'x35'	330 ton per furnace Gas usage for both furnace: 648 cfm max. measured and 736.7 cfm (402 gph) max. estimated	Existing

Equipment	Quantity	Manufacturer	Model/Type	Serial No.	Date Installed or modified	Size	Rated Capacity	New or Existing
Anode steam boiler	1	Parker	Packaged boiler horizontal drum, natural gas fired	n/a	1995	90 HP	3,780,000 Btu/hr	Existing
Anode casting wheels, north & south	2	Stearns-Rodgers Corporation	n/a	n/a	1972	29' diameter	24 mold	Existing
Anode launder burners	6	Hauck	RFS 1120A Natural gas fired	n/a	1972	2"	n/a	Existing
Anode ladle burners	3	ASARCO	Natural gas fired	n/a	1972	4"	n/a	Existing
<b>Oxygen Plant:</b>								
Oxygen plant boiler	1	General Electric	CB Packaged Boiler 700X-300, natural gas fired	L-75227	1982	n/a	8,740,000 Btu/hr 8,740 CFH designed natural gas usage	Existing
Oxygen plant	1	Air Products	Consists of main air compressor, oxygen compressor, direct contact after cooler, liquid oxygen storage tank and cooling tower	n/a	1983	n/a	650 tpd gaseous oxygen 5,694,000 tpy	Existing
<b>Furnace Ventilation Gas Control:</b>								
R & R Electrostatic precipitator	1	ASARCO Inc.	Plate wire	n/a	built in 1961 and expanded in 1968	62'x76'	43,350 dscfm	n/a
R & R ESP screw conveyors #1-15, 17, 18	17	Screw Conveyor Corporation	n/a	n/a	1968	#1-15: 9" #17, 18: 12"	12 tph, 105,120 tpy	Existing
R & R ESP Bucket Elevator	1	Automation Supply	3-SA	n/a	1975	48' center to center	35 tph, 306,600 tpy	Existing

Equipment	Quantity	Manufacturer	Model/Type	Serial No.	Date Installed or Modified	Size	Rated Capacity	New or Existing
R & R ESP Pugmill	1	Automation Supply & Engineering	Double shaft	n/a	1968	n/a	15 ton storage	Existing
<b>Other Processes:</b>								
Reverts (matte & slag) Screen #1, south of acid tanks	1	Screen USA	BF35E2/two deck 4'x8' for closed single deck and 12'x14' for open single deck	3011096	1996	4'x8' and 12'x14'	100 tph, 44,000 tpy	New
Reverts (matte & slag) Screen #2, south of converter isle	1	Grizzly	Open single deck	n/a	1994	10'x15' 33/34" openings	200 tph, 40,000 tpy	New
WTP lime silo	1	Portec	850-QLH/Steel	n/a	1983	n/a	150 ton	Existing
WTP lime silo baghouse	1	Portec	DF-44	n/a	1983	1 HP	1,176 cfm	n/a
0.5 million gallon diesel storage tank	1	Garland Steel Company	steel	n/a	fourth quarter 1971	500,000 gallons diameter 52 feet height 32 feet	n/a	Existing

Table C-2. Stack Information

Identification	Description	Building Size	Exit Gas Temperature	Exit Gas Velocity	Height	Inside Dimensions
HP-1	Acid plant (main stack core)	n/a	303 °F	19 fps	1000 feet	17 foot diameter
HP-2	Main stack annulus (ventilation gases)	n/a	135 °F	34 fps	920 feet	432 sq. ft.
HP-4	Revert crusher baghouse stack	n/a	99 °F	42 fps	46 feet	3.83 foot diameter
HP-26	#2 acid plant preheater	n/a	n/a	n/a	65 feet	5.42 foot diameter
HP-28	Oxygen plant boiler	n/a	346 °F (estimated)	1,650 scfm (estimated)	22 feet	1.66 foot diameter

Identification	Description	Building Size	Exit Gas Temperature	Exit Gas Velocity	Height	Inside Dimensions
HP-32	200 ton dry #1 bin ventilation baghouse (located inside furnace building)	n/a	Unknown	Capacity 1050 acfm	6 feet	0.5' x 0.5'
HP-33	200 ton dry #2 bin ventilation baghouse (located inside furnace building)	n/a	Unknown	Capacity 1050 acfm	6 feet	0.5' x 0.5'
HP-34	200 ton dry #3 bin ventilation baghouse (located inside furnace building)	n/a	Unknown	Capacity 1050 acfm	6 feet	0.5' x 0.5'
HP-35	200 ton dry #4 bin ventilation baghouse (located inside furnace building)	n/a	Unknown	Capacity 1050 acfm	6 feet	0.5' x 0.5'
HP-38	30 ton dust bin ventilation baghouse #1 (part of pneumatic conveying system)	n/a	Ambient	Capacity 480 acfm	12.25 feet	0.68' x 0.66'
HP-39	30 ton dust bin ventilation baghouse #2 (part of pneumatic conveying system)	n/a	Ambient	Capacity 480 acfm	12.25 feet	0.68' x 0.66'
HP-50	Anode steam boiler	n/a	n/a	n/a	32 feet	20 inch diameter

Table C-3. Continuous Emission Monitoring Systems Information

Type	Manufacturer	Model	Serial No.	Range	Location
Acid Plant Tail Gas SO <sub>2</sub> Monitor	Ametek	4600B - Analyzer 4000 - Control Station	6146	0-0.20% SO <sub>2</sub>	At the acid plant exit prior to the merging with the main flue to stack
Acid Plant Tail Gas Flow Monitor	EMRC/Rosemount	Mark 5/ 3051CD1A22A1AB4MS	0306343	0-2.5 "H <sub>2</sub> O Dp S-Type Pitot	At the acid plant exit prior to the merging with the main flue to stack
Acid Plant Tail Gas Opacity Monitor	Lear Ziegler	1100M	0833	0-100% opacity	At the acid plant exit prior to the merging with the main flue to stack
R & R Flue Opacity Monitor	Monitor Labs	550	5500157	0-100% opacity	At outlet flue of the R & R Cottrell ESP prior to the merging with the secondary hoods off-gas flue
Converter Secondary Hoods Off-gas SO <sub>2</sub> Monitor	Ametek	4600B - Analyzer 4000 - Control Station	5289	0-1.0% SO <sub>2</sub>	At the secondary hooding flue before baghouse

Type	Manufacturer	Model	Serial No.	Range	Location
Converter Secondary Hoods Off-gas Flow Monitor	EMRC/Rosemount	Mark 5/ 3051CD1A22A1AB4M5	86585	0-2.5 "H <sub>2</sub> O Dp S-Type Pitot	At the secondary hooding flue before baghouse
Furnace Ventilation Gas SO <sub>2</sub> Monitor	Ametek	4600B - Analyzer 4000 - Control Station	6274	0-0.4% SO <sub>2</sub>	At the furnace vent flue prior to the merging with dryer exhaust gases
Furnace Ventilation Gas Flow Monitor	EMRC/Rosemount	Mark 5/ 3051CD1A22A1AB4E5	0538569	0-2.5 "H <sub>2</sub> O Dp S-Type Pitot	At the furnace vent flue prior to the merging with dryer exhaust gases

Table C-4. Ambient Sulfur Dioxide Analyzers in the Hayden Area

Identifier	Unit	Make/Model	Owned and Operated by	Location
MT0	Montgomery Ranch	Thermo Environmental pulsed fluorescent Model 43B	ASARCO	2.52 miles northwest of ASARCO
JL	Jail - ASARCO	Thermo Environmental pulsed fluorescent Model 43C	ASARCO	0.58 miles west of ASARCO
HJ0	Hayden Junction	Thermo Environmental pulsed fluorescent Model 43B	ASARCO	2.00 miles west of ASARCO
GA	Garfield Avenue	Thermo Environmental pulsed fluorescent Model 43C	ASARCO	0.56 miles south of ASARCO
GH0	Globe Highway	Thermo Environmental pulsed fluorescent Model 43B	ASARCO	0.50 miles east of ASARCO
JL	Jail - ADEQ	Thermo Electron pulsed fluorescent (TECO) Model 40	ADEQ	0.58 miles west of ASARCO

**MINOR PERMIT REVISION NO. 54251**  
**To**  
**AIR QUALITY PERMIT NO. 1000042**  
**ASARCO- HAYDEN SMELTER**  
**ATTACHMENT "C"**

Following equipment are added to the equipment list (Attachment "C") of Permit No. 1000042.

Equipment	Rated capacity	Manufacturer	Model No.	Serial No.	Date Installed or modified
Anode Baghouse	69,500 scfm	MikroPul	323(6.25)-16-30TRH	TBD	TBD

TBD: To be decided

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## STACK PARAMETERS

**ASARCO Hayden Operations - Hayden Smelter  
Hayden, Arizona  
Acid Plant**

Diameter of Duct: 98 inches (8.167 ft.)

Area of Stack: 52.382 sq. ft.

Duct diameters downstream from flow disturbance

(port location with respect to acid plant): >8 d

Duct diameters upstream from flow disturbance

(port location with respect to stack exit): >2 d

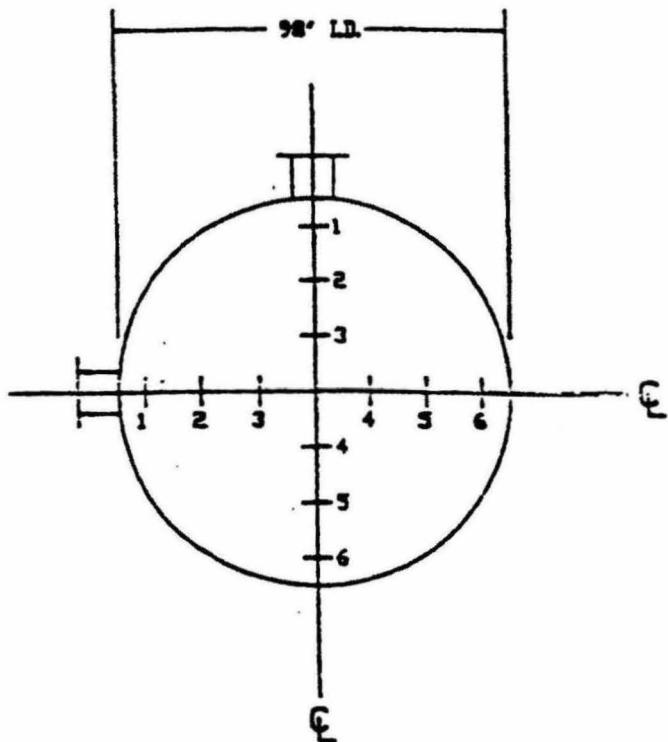
Number of sample ports: 2 @ 90 degrees

Number of sample (traverse) points: 12 (6 per port)

Location of traverse points (from inside wall):

- 1) 4.31 inches
- 2) 14.31 inches
- 3) 29.01 inches
- 4) 68.99 inches
- 5) 83.69 inches
- 6) 93.69 inches

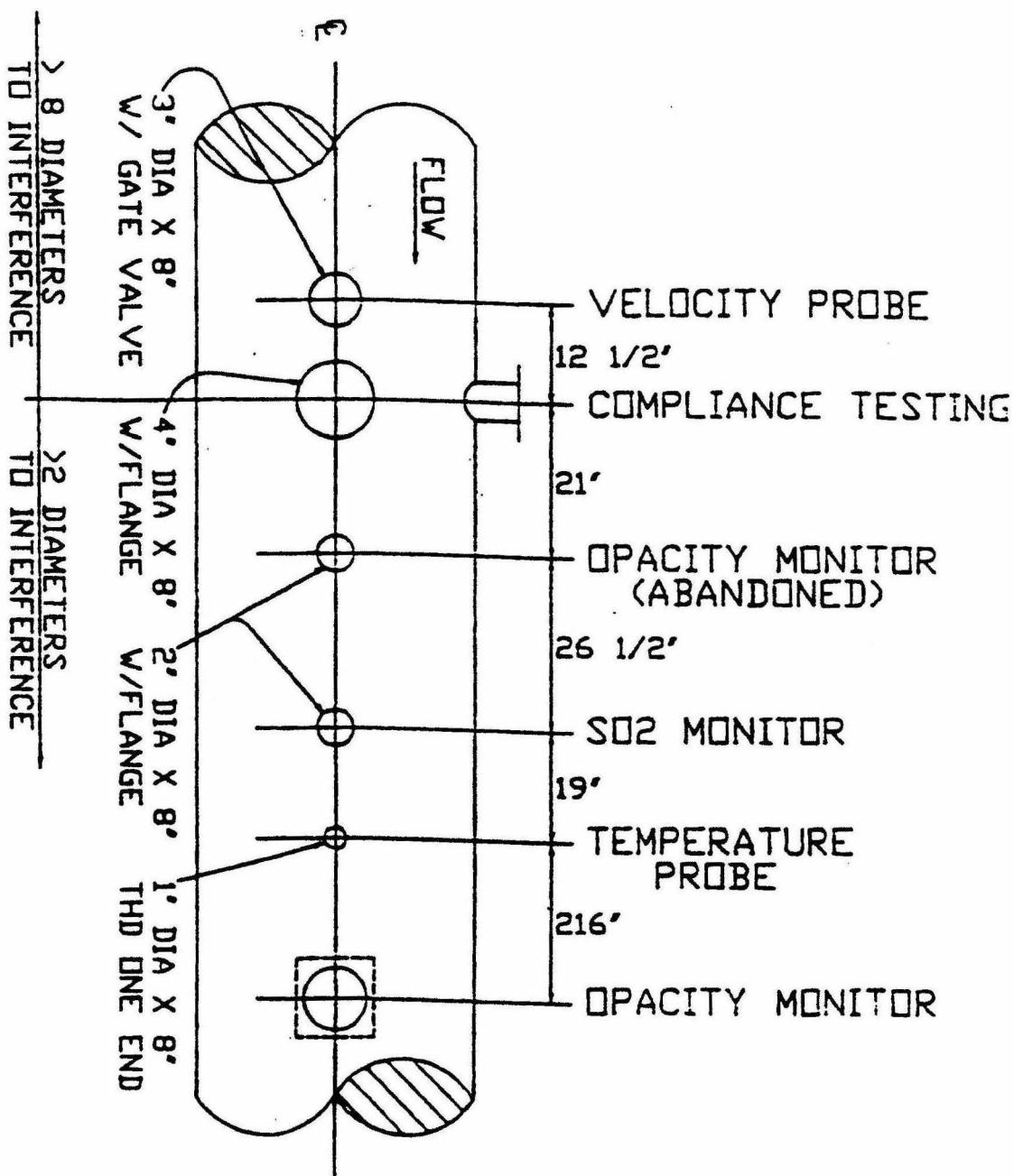
DUCT DIAMETER - 98 in. (8.167 ft.)  
AREA OF DUCT - 52.382 sq. ft.  
NUMBER OF SAMPLE PORTS - 2090 degrees  
NUMBER OF SAMPLE POINTS - 12



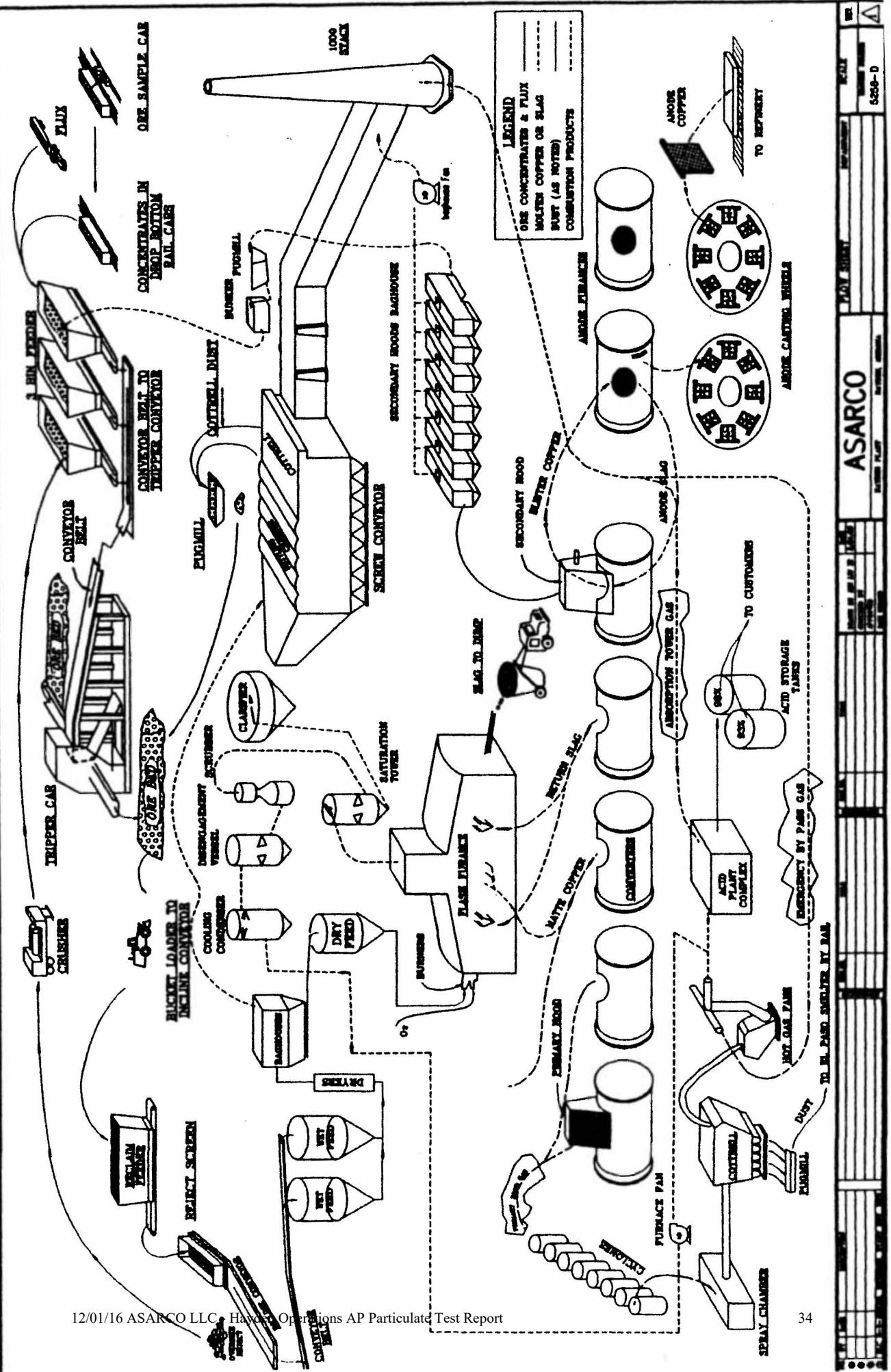
LOCATION OF SAMPLE POINTS:  
(from inside wall)

1. 4.31 in.
2. 14.31 in.
3. 29.01 in.
4. 68.99 in.
5. 83.89 in.
6. 93.69 in.

No. 2 ACID PLANT MONITORING STATION



No. 2 ACID PLANT MONITORING STATION



Date Time	Furnace Feed	Converter Blowing Rate					Number	Tower Acid Flow	
	TPH	SCFM					Converters	GPM	
	Feed	#1	#2	#3	#4	#5	Blowing	Interpass	Final
<b>Acid Plant - Particulates</b>									
<b>12:48 to 17:05</b>									
12/19/2016 12:49	74	0	49	0	76	21139	1	5277	2425
12/19/2016 12:50	73	0	46	0	78	22474	1	5251	2433
12/19/2016 12:51	73	0	58	0	89	67	0	5297	2452
12/19/2016 12:52	72	0	40	0	64	19808	1	5239	2450
12/19/2016 12:53	81	0	49	0	73	21118	1	5275	2437
12/19/2016 12:54	76	0	48	0	74	20336	1	5285	2454
12/19/2016 12:55	75	0	48	0	70	19502	1	5317	2447
12/19/2016 12:56	75	0	45	0	68	4026	1	5281	2453
12/19/2016 12:57	75	0	39	0	73	8898	1	5344	2469
12/19/2016 12:58	70	0	50	0	75	18429	1	5274	2431
12/19/2016 12:59	70	0	49	0	70	18118	1	5296	2453
12/19/2016 13:00	73	0	44	0	69	18159	1	5275	2466
12/19/2016 13:01	73	0	44	0	66	18132	1	5297	2458
12/19/2016 13:02	73	0	48	0	64	18801	1	5324	2467
12/19/2016 13:03	74	0	51	0	78	18564	1	5236	2471
12/19/2016 13:04	74	0	43	0	67	16268	1	5266	2441
12/19/2016 13:05	73	0	53	0	87	38	0	5288	2470
12/19/2016 13:06	75	0	49	0	77	16	0	5292	2440
12/19/2016 13:07	81	0	50	0	76	17150	1	5391	2439
12/19/2016 13:08	75	0	59	0	82	382	0	5268	2440
12/19/2016 13:09	75	0	48	0	70	14	0	5324	2429
12/19/2016 13:10	74	0	49	0	66	12	0	5292	2440
12/19/2016 13:11	75	0	48	0	68	12	0	5282	2447
12/19/2016 13:12	74	0	48	0	71	13	0	5376	2430
12/19/2016 13:13	74	0	45	0	74	17	0	5251	2443
12/19/2016 13:14	77	0	44	0	71	15	0	5294	2457
12/19/2016 13:15	78	0	47	0	71	17	0	5261	2461
12/19/2016 13:16	77	0	42	0	72	18	0	5208	2461
12/19/2016 13:17	74	0	47	0	73	19	0	5372	2435
12/19/2016 13:18	75	0	52	0	81	19	0	5248	2432
12/19/2016 13:19	79	0	42	0	76	21	0	5278	2441
12/19/2016 13:20	77	0	55	0	85	22	0	5411	2430
12/19/2016 13:21	76	0	53	0	85	23	0	5268	2437
12/19/2016 13:22	78	0	53	0	83	22	0	5293	2459
12/19/2016 13:23	73	0	55	0	18231	13	1	5204	2423
12/19/2016 13:24	76	0	53	0	19361	12	1	5310	2454
12/19/2016 13:25	76	0	48	0	19199	0	1	5241	2447
12/19/2016 13:26	75	0	46	0	19313	2	1	5181	2450
12/19/2016 13:27	76	0	51	0	19477	0	1	5254	2429
12/19/2016 13:28	75	0	48	0	18954	0	1	5266	2443
12/19/2016 13:29	75	0	46	0	18678	0	1	5337	2460
12/19/2016 13:30	74	0	47	0	18673	0	1	5254	2439
12/19/2016 13:31	72	0	43	0	18532	0	1	5267	2453
12/19/2016 13:32	104	0	48	0	18377	0	1	5273	2469

Date Time	Furnace Feed	Converter Blowing Rate					Number	Tower Acid Flow	
	TPH	SCFM					Converters	GPM	
	Feed	#1	#2	#3	#4	#5	Blowing	Interpass	Final
12/19/2016 13:33	82	0	45	0	18328	0	1	5277	2480
12/19/2016 13:34	80	0	48	0	18391	0	1	5352	2495
12/19/2016 13:35	81	0	46	0	18232	0	1	5311	2472
12/19/2016 13:36	82	0	44	0	18224	0	1	5323	2472
12/19/2016 13:37	81	0	48	0	18415	0	1	5250	2468
12/19/2016 13:38	84	0	44	0	18294	0	1	5289	2433
12/19/2016 13:39	81	0	48	0	18126	0	1	5363	2482
12/19/2016 13:40	82	0	47	0	17921	0	1	5414	2456
12/19/2016 13:41	82	0	45	0	17894	0	1	5339	2460
12/19/2016 13:42	81	0	50	0	17784	0	1	5311	2484
12/19/2016 13:43	80	0	46	0	17533	0	1	5331	2460
12/19/2016 13:44	63	0	46	0	16994	0	1	5233	2473
12/19/2016 13:45	54	0	43	0	16323	0	1	5274	2456
12/19/2016 13:46	52	0	34	0	15499	0	1	5262	2442
12/19/2016 13:47	52	0	31	0	14770	0	1	5353	2461
12/19/2016 13:48	50	14390	59	0	13964	12	2	5327	2457
12/19/2016 13:49	50	6648	65	0	14126	15	2	5292	2451
12/19/2016 13:50	49	0	47	0	14493	0	1	5291	2479
12/19/2016 13:51	50	0	38	0	14792	0	1	5347	2439
12/19/2016 13:52	50	15378	59	0	16137	19	2	5311	2448
12/19/2016 13:53	49	17026	60	0	16416	13	2	5222	2477
12/19/2016 13:54	51	17094	63	0	14953	14	2	5316	2437
12/19/2016 13:55	49	18736	62	0	13156	14	2	5370	2457
12/19/2016 13:56	49	22076	66	0	12251	18	2	5305	2443
12/19/2016 13:57	49	21491	67	0	13476	20	2	5222	2462
12/19/2016 13:58	51	20379	62	0	14541	22	2	5275	2467
12/19/2016 13:59	51	19231	63	0	0	16548	2	5217	2474
12/19/2016 14:00	85	18234	66	0	0	18	1	5246	2431
12/19/2016 14:01	78	17275	58	0	0	0	1	5312	2428
12/19/2016 14:02	77	13037	50	0	0	0	1	5326	2454
12/19/2016 14:03	74	9879	60	0	12100	20	2	5333	2443
12/19/2016 14:04	76	12263	62	0	13280	19	2	5272	2458
12/19/2016 14:05	75	13643	65	0	13806	21	2	5283	2445
12/19/2016 14:06	74	11148	63	0	12903	17	2	5299	2451
12/19/2016 14:07	75	8686	59	0	16056	21	2	5284	2456
12/19/2016 14:08	77	7832	60	0	15975	19	2	5370	2417
12/19/2016 14:09	76	8620	56	0	16266	17	2	5370	2460
12/19/2016 14:10	75	9390	58	0	16496	14	2	5341	2452
12/19/2016 14:11	75	14064	62	0	16843	16	2	5257	2475
12/19/2016 14:12	73	10628	62	0	17271	13	2	5275	2425
12/19/2016 14:13	75	9156	60	0	17304	17	2	5313	2437
12/19/2016 14:14	76	10674	64	0	17440	16	2	5338	2440
12/19/2016 14:15	76	12756	67	0	17873	18	2	5304	2453
12/19/2016 14:16	75	0	60	0	18276	0	1	5345	2418
12/19/2016 14:17	76	0	58	0	17881	0	1	5253	2428
12/19/2016 14:18	74	0	56	0	17894	0	1	5271	2434

Date Time	Furnace Feed	Converter Blowing Rate					Number	Tower Acid Flow	
	TPH	SCFM					Converters	GPM	
	Feed	#1	#2	#3	#4	#5	Blowing	Interpass	Final
12/19/2016 14:19	73	0	57	0	17870	0	1	5252	2474
12/19/2016 14:20	75	0	56	0	17628	0	1	5390	2427
12/19/2016 14:21	76	0	54	0	17482	0	1	5287	2452
12/19/2016 14:22	73	11300	64	0	17006	16	2	5321	2459
12/19/2016 14:23	74	13175	65	0	16771	17	2	5286	2465
12/19/2016 14:24	101	13360	65	0	16271	18	2	5371	2464
12/19/2016 14:25	103	14933	66	0	15960	16	2	5302	2459
12/19/2016 14:26	99	12142	67	0	15470	17	2	5235	2427
12/19/2016 14:27	100	10696	65	0	14644	16	2	5292	2454
12/19/2016 14:28	99	15235	69	0	14075	17	2	5295	2468
12/19/2016 14:29	98	11502	67	0	13799	16	2	5263	2458
12/19/2016 14:30	102	7326	63	0	13899	11	2	5237	2457
12/19/2016 14:31	100	0	51	0	13254	0	1	5321	2446
12/19/2016 14:32	99	0	42	0	12667	0	1	5337	2465
12/19/2016 14:33	101	0	41	0	11814	0	1	5317	2464
12/19/2016 14:34	100	0	40	0	12321	0	1	5286	2465
12/19/2016 14:35	101	0	48	0	14728	0	1	5240	2447
12/19/2016 14:36	98	0	58	0	17758	0	1	5340	2453
12/19/2016 14:37	101	6265	64	0	18798	11	2	5294	2500
12/19/2016 14:38	100	5545	65	0	17875	20	2	5309	2457
12/19/2016 14:39	99	9281	64	0	16675	14	2	5259	2413
12/19/2016 14:40	101	12380	67	0	15400	18	2	5259	2419
12/19/2016 14:41	101	14038	71	0	14316	16	2	5289	2468
12/19/2016 14:42	99	15598	69	0	12967	18	2	5312	2459
12/19/2016 14:43	99	14467	70	0	11589	12	2	5244	2488
12/19/2016 14:44	100	11448	67	0	10237	14	2	5274	2468
12/19/2016 14:45	101	9897	49	0	1241	0	1	5290	2431
12/19/2016 14:46	98	11917	48	0	0	0	1	5338	2444
12/19/2016 14:47	97	12255	50	0	0	0	1	5333	2434
12/19/2016 14:48	101	13321	56	0	0	0	1	5321	2479
12/19/2016 14:49	101	14653	59	0	5160	0	2	5274	2471
12/19/2016 14:50	99	1964	62	0	8738	0	1	5292	2443
12/19/2016 14:51	101	0	54	0	8543	7	1	5313	2427
12/19/2016 14:52	98	0	54	0	9208	5	1	5292	2418
12/19/2016 14:53	100	0	57	0	13871	0	1	5349	2436
12/19/2016 14:54	98	0	56	0	15357	0	1	5350	2430
12/19/2016 14:55	101	0	56	0	15411	0	1	5248	2457
12/19/2016 14:56	100	0	56	0	15483	0	1	5271	2436
12/19/2016 14:57	99	0	53	0	14822	0	1	5260	2404
12/19/2016 14:58	99	0	47	0	14205	0	1	5265	2467
12/19/2016 14:59	100	0	46	0	13728	0	1	5234	2475
12/19/2016 15:00	102	0	43	0	12846	0	1	5238	2420
12/19/2016 15:01	99	0	48	0	12446	0	1	5305	2462
12/19/2016 15:02	99	0	42	0	11951	0	1	5324	2475
12/19/2016 15:03	100	8558	54	0	10732	2	2	5300	2472
12/19/2016 15:04	97	13756	69	0	11540	13	2	5292	2464

Date Time	Furnace Feed	Converter Blowing Rate					Number	Tower Acid Flow	
	TPH	SCFM					Converters	GPM	
	Feed	#1	#2	#3	#4	#5	Blowing	Interpass	Final
12/19/2016 15:05	99	15890	68	0	11335	18	2	5384	2486
12/19/2016 15:06	101	19094	74	0	12847	18	2	5343	2466
12/19/2016 15:07	99	19950	71	0	15591	8	2	5345	2479
12/19/2016 15:08	101	18304	68	0	17320	9	2	5338	2461
12/19/2016 15:09	100	16970	70	0	17060	15	2	5284	2475
12/19/2016 15:10	99	18577	74	0	15657	10	2	5357	2470
12/19/2016 15:11	98	19439	72	0	14309	14	2	5277	2465
12/19/2016 15:12	100	19630	77	0	12221	17	2	5325	2433
12/19/2016 15:13	98	19266	77	0	11181	20	2	5325	2428
12/19/2016 15:14	99	20616	77	0	10036	22	2	5319	2477
12/19/2016 15:15	99	17544	74	0	9437	21	2	5281	2440
12/19/2016 15:16	99	14685	73	0	10639	16	2	5270	2446
12/19/2016 15:17	100	11777	70	0	10035	19	2	5263	2435
12/19/2016 15:18	95	13965	72	0	8820	17	2	5323	2473
12/19/2016 15:19	95	16427	73	0	9042	16	2	5317	2469
12/19/2016 15:20	95	16296	71	0	12057	15	2	5331	2483
12/19/2016 15:21	97	14117	74	0	14687	22	2	5251	2466
12/19/2016 15:22	95	13196	73	0	16165	24	2	5235	2456
12/19/2016 15:23	98	5	73	0	0	30	0	5357	2419
12/19/2016 15:24	99	0	70	0	0	15	0	5317	2458
12/19/2016 15:25	99	0	68	0	0	27	0	5352	2468
12/19/2016 15:26	100	12651	73	0	0	26	1	5278	2440
12/19/2016 15:27	97	17535	74	0	0	10	1	5312	2465
12/19/2016 15:28	98	20013	78	0	0	14	1	5287	2469
12/19/2016 15:29	103	20028	81	0	0	16	1	5228	2415
12/19/2016 15:30	102	19365	79	0	0	15	1	5296	2424
12/19/2016 15:31	99	19678	78	0	0	15	1	5307	2449
12/19/2016 15:32	97	20777	79	0	0	23	1	5255	2406
12/19/2016 15:33	100	1	75	0	0	33	0	5246	2435
12/19/2016 15:34	101	0	67	0	14795	12	1	5216	2454
12/19/2016 15:35	99	0	62	0	14545	0	1	5312	2462
12/19/2016 15:36	98	0	59	0	14615	0	1	5334	2434
12/19/2016 15:37	99	0	57	0	14626	0	1	5324	2445
12/19/2016 15:38	99	0	59	0	14703	0	1	5270	2458
12/19/2016 15:39	99	0	53	0	14586	0	1	5364	2431
12/19/2016 15:40	100	0	60	0	14585	0	1	5278	2434
12/19/2016 15:41	99	0	56	0	14632	0	1	5305	2446
12/19/2016 15:42	99	0	56	0	14580	0	1	5333	2443
12/19/2016 15:43	100	0	53	0	14595	0	1	5301	2458
12/19/2016 15:44	101	0	59	0	14520	0	1	5303	2456
12/19/2016 15:45	104	0	58	0	14625	0	1	5308	2453
12/19/2016 15:46	100	0	55	0	14737	0	1	5252	2459
12/19/2016 15:47	98	0	58	0	14781	0	1	5338	2445
12/19/2016 15:48	100	0	55	0	14740	0	1	5309	2470
12/19/2016 15:49	99	0	56	0	14721	0	1	5321	2444
12/19/2016 15:50	99	0	51	0	14888	0	1	5369	2437

Date Time	Furnace Feed	Converter Blowing Rate					Number	Tower Acid Flow	
	TPH	SCFM					Converters	GPM	
	Feed	#1	#2	#3	#4	#5	Blowing	Interpass	Final
12/19/2016 15:51	97	0	56	0	15073	0	1	5283	2459
12/19/2016 15:52	73	0	59	0	15023	0	1	5309	2477
12/19/2016 15:53	74	0	60	0	15054	0	1	5272	2433
12/19/2016 15:54	73	0	57	0	15149	0	1	5383	2462
12/19/2016 15:55	73	0	58	0	15399	0	1	5227	2434
12/19/2016 15:56	75	0	59	0	15599	0	1	5253	2419
12/19/2016 15:57	75	0	64	0	15554	0	1	5299	2446
12/19/2016 15:58	113	0	63	0	14347	24728	2	5298	2446
12/19/2016 15:59	105	0	63	0	14895	23552	2	5310	2450
12/19/2016 16:00	99	0	65	0	15572	21755	2	5273	2449
12/19/2016 16:01	97	0	66	0	15628	21112	2	5353	2451
12/19/2016 16:02	99	0	64	0	15346	22613	2	5245	2453
12/19/2016 16:03	98	0	66	0	15817	21253	2	5319	2440
12/19/2016 16:04	100	0	65	0	15766	21728	2	5335	2421
12/19/2016 16:05	100	0	67	0	16089	20000	2	5276	2480
12/19/2016 16:06	101	0	66	0	16117	20195	2	5308	2439
12/19/2016 16:07	99	0	66	0	16781	17742	2	5310	2444
12/19/2016 16:08	96	0	66	0	16491	19075	2	5300	2460
12/19/2016 16:09	101	0	67	0	16769	18838	2	5284	2489
12/19/2016 16:10	102	0	68	0	17324	16455	2	5301	2433
12/19/2016 16:11	102	0	67	0	17319	12285	2	5333	2478
12/19/2016 16:12	102	0	68	0	17278	13645	2	5362	2449
12/19/2016 16:13	105	0	67	0	17597	15383	2	5365	2440
12/19/2016 16:14	101	0	66	0	17571	15999	2	5339	2506
12/19/2016 16:15	107	0	68	0	17632	17150	2	5309	2456
12/19/2016 16:16	110	0	68	0	17971	13575	2	5287	2486
12/19/2016 16:17	110	0	68	0	17868	10574	2	5333	2461
12/19/2016 16:18	107	0	67	0	17859	9793	2	5265	2450
12/19/2016 16:19	106	0	69	0	18037	10200	2	5294	2410
12/19/2016 16:20	104	0	63	0	17731	0	1	5251	2449
12/19/2016 16:21	105	0	65	0	17679	0	1	5317	2473
12/19/2016 16:22	103	0	67	0	17823	11161	2	5325	2436
12/19/2016 16:23	101	0	66	0	17766	15901	2	5338	2458
12/19/2016 16:24	94	0	64	0	17735	19112	2	5244	2457
12/19/2016 16:25	105	0	66	0	18020	18552	2	5322	2448
12/19/2016 16:26	98	0	64	0	17423	19913	2	5365	2445
12/19/2016 16:27	100	0	66	0	17890	17686	2	5257	2454
12/19/2016 16:28	102	0	68	0	18227	15223	2	5299	2447
12/19/2016 16:29	97	0	67	0	17860	13614	2	5267	2425
12/19/2016 16:30	101	0	66	0	17697	16535	2	5327	2444
12/19/2016 16:31	103	0	70	0	365	19072	1	5302	2433
12/19/2016 16:32	101	0	69	0	17883	14583	2	5349	2414
12/19/2016 16:33	99	0	68	0	17400	11288	2	5318	2464
12/19/2016 16:34	101	0	67	0	16889	8601	2	5270	2430
12/19/2016 16:35	99	0	66	0	16565	9025	2	5307	2456
12/19/2016 16:36	76	0	66	0	16349	11474	2	5311	2458

Date Time	Furnace Feed	Converter Blowing Rate					Number	Tower Acid Flow	
	TPH	SCFM					Converters	GPM	
	Feed	#1	#2	#3	#4	#5	Blowing	Interpass	Final
12/19/2016 16:37	76	0	65	0	15934	19553	2	5295	2428
12/19/2016 16:38	75	0	69	0	2672	19709	2	5381	2454
12/19/2016 16:39	74	0	66	0	0	18213	1	5313	2421
12/19/2016 16:40	76	0	67	0	16043	18603	2	5353	2452
12/19/2016 16:41	75	0	67	0	15717	15496	2	5321	2482
12/19/2016 16:42	75	0	59	0	15158	134	1	5318	2443
12/19/2016 16:43	75	0	63	0	13660	13273	2	5297	2421
12/19/2016 16:44	75	0	66	0	13513	10792	2	5257	2415
12/19/2016 16:45	76	0	66	0	12862	8433	2	5269	2482
12/19/2016 16:46	76	0	66	0	12016	10819	2	5275	2472
12/19/2016 16:47	76	0	60	0	137	13780	1	5341	2419
12/19/2016 16:48	74	0	59	0	6562	17123	2	5307	2465
12/19/2016 16:49	75	0	67	0	11531	17275	2	5270	2443
12/19/2016 16:50	75	0	45	0	12058	896	1	5330	2426
12/19/2016 16:51	75	0	52	0	13807	0	1	5300	2447
12/19/2016 16:52	74	0	48	0	15601	0	1	5294	2446
12/19/2016 16:53	73	0	52	0	14897	0	1	5315	2439
12/19/2016 16:54	74	0	53	0	14167	0	1	5353	2478
12/19/2016 16:55	76	0	70	0	328	15	0	5321	2397
12/19/2016 16:56	76	0	62	0	13083	0	1	5305	2414
12/19/2016 16:57	76	0	67	0	1323	5	0	5233	2404
12/19/2016 16:58	75	0	67	0	0	17	0	5336	2451
12/19/2016 16:59	75	0	65	0	0	17	0	5271	2445
12/19/2016 17:00	76	0	60	0	0	16	0	5277	2440
12/19/2016 17:01	75	0	63	0	0	14	0	5294	2431
12/19/2016 17:02	75	0	65	0	0	17	0	5300	2427
12/19/2016 17:03	77	18708	78	0	0	11	1	5275	2480
12/19/2016 17:04	74	22962	87	0	0	10	1	5340	2456
12/19/2016 17:05	74	24304	81	0	0	10	1	5340	2429
<b>09:23 to 13:29</b>									
12/20/2016 9:24	101	0	18540	0	102	18597	2	5329	2450
12/20/2016 9:25	101	0	184	0	104	18342	1	5240	2437
12/20/2016 9:26	104	0	16529	0	105	17165	2	5327	2446
12/20/2016 9:27	100	0	18414	0	101	16674	2	5272	2497
12/20/2016 9:28	100	0	16793	0	104	16498	2	5285	2428
12/20/2016 9:29	103	0	12436	0	101	15650	2	5299	2481
12/20/2016 9:30	102	0	16375	0	97	15472	2	5325	2437
12/20/2016 9:31	99	0	13803	0	15833	15778	3	5255	2442
12/20/2016 9:32	99	0	13647	0	106	23689	2	5268	2455
12/20/2016 9:33	97	0	17279	0	102	21932	2	5338	2482
12/20/2016 9:34	109	0	16387	0	102	21460	2	5265	2479
12/20/2016 9:35	101	0	12856	0	106	21469	2	5367	2444
12/20/2016 9:36	78	0	12507	0	105	20017	2	5349	2464
12/20/2016 9:37	76	0	16584	0	18633	36	2	5330	2448

Date Time	Furnace Feed	Converter Blowing Rate					Number	Tower Acid Flow	
	TPH	SCFM					Converters	GPM	
	Feed	#1	#2	#3	#4	#5	Blowing	Interpass	Final
12/20/2016 9:38	75	0	112	0	131	0	0	5244	2482
12/20/2016 9:39	75	0	96	0	99	16008	1	5320	2475
12/20/2016 9:40	75	0	105	0	110	15654	1	5267	2419
12/20/2016 9:41	75	0	90	0	105	14371	1	5245	2480
12/20/2016 9:42	76	0	85	0	103	13978	1	5385	2444
12/20/2016 9:43	102	0	78	0	98	12870	1	5266	2454
12/20/2016 9:44	102	0	71	0	95	12678	1	5317	2418
12/20/2016 9:45	102	0	69	0	98	14717	1	5242	2486
12/20/2016 9:46	98	0	77	0	104	18695	1	5251	2455
12/20/2016 9:47	98	0	77	0	18629	19927	2	5345	2408
12/20/2016 9:48	99	0	77	0	21330	17301	2	5365	2435
12/20/2016 9:49	98	0	75	0	22886	15433	2	5252	2426
12/20/2016 9:50	97	0	71	0	23309	14140	2	5293	2442
12/20/2016 9:51	102	0	73	0	24305	13103	2	5251	2420
12/20/2016 9:52	98	0	71	0	25204	12274	2	5263	2439
12/20/2016 9:53	98	0	71	0	25783	11000	2	5276	2409
12/20/2016 9:54	98	0	71	0	886	14113	1	5278	2445
12/20/2016 9:55	101	0	65	0	114	18079	1	5382	2440
12/20/2016 9:56	103	0	69	0	119	18377	1	5337	2445
12/20/2016 9:57	93	0	56	0	107	14753	1	5295	2423
12/20/2016 9:58	99	0	51	0	96	15845	1	5253	2465
12/20/2016 9:59	101	0	60	0	107	17059	1	5276	2481
12/20/2016 10:00	75	0	62	0	105	17171	1	5295	2476
12/20/2016 10:01	75	0	55	0	103	16531	1	5301	2446
12/20/2016 10:02	74	0	48	0	105	15610	1	5281	2454
12/20/2016 10:03	75	0	37	0	98	15283	1	5303	2467
12/20/2016 10:04	74	0	37	0	99	14349	1	5335	2469
12/20/2016 10:05	76	0	36	0	90	12782	1	5305	2474
12/20/2016 10:06	103	0	40	0	90	12648	1	5330	2469
12/20/2016 10:07	102	0	64	0	119	449	0	5313	2449
12/20/2016 10:08	99	0	64	0	115	26	0	5268	2464
12/20/2016 10:09	100	0	40	0	94	10299	1	5256	2424
12/20/2016 10:10	100	0	16574	0	100	10737	2	5334	2440
12/20/2016 10:11	100	0	19164	0	101	14239	2	5325	2448
12/20/2016 10:12	97	0	20253	0	97	19273	2	5283	2418
12/20/2016 10:13	97	0	20518	0	90	21141	2	5237	2473
12/20/2016 10:14	99	0	19032	0	96	20251	2	5230	2408
12/20/2016 10:15	98	0	64	0	102	19812	1	5404	2415
12/20/2016 10:16	100	0	45	0	92	17587	1	5226	2465
12/20/2016 10:17	98	0	34	0	91	15921	1	5299	2478
12/20/2016 10:18	104	0	29	0	91	14315	1	5318	2448
12/20/2016 10:19	98	0	24	0	84	13179	1	5368	2466
12/20/2016 10:20	103	0	23	0	73	12237	1	5303	2452
12/20/2016 10:21	76	0	22	0	78	11456	1	5278	2487
12/20/2016 10:22	75	0	25	0	88	14354	1	5307	2469
12/20/2016 10:23	83	0	52	0	115	52	0	5266	2464

Date Time	Furnace Feed	Converter Blowing Rate					Number	Tower Acid Flow	
	TPH	SCFM					Converters	GPM	
	Feed	#1	#2	#3	#4	#5	Blowing	Interpass	Final
12/20/2016 10:24	75	0	54	0	111	26	0	5273	2471
12/20/2016 10:25	70	0	53	0	104	14353	1	5325	2435
12/20/2016 10:26	77	0	42	0	95	15335	1	5306	2438
12/20/2016 10:27	76	0	47	0	101	22442	1	5374	2463
12/20/2016 10:28	76	0	47	0	103	21953	1	5301	2481
12/20/2016 10:29	76	0	49	0	103	22243	1	5252	2447
12/20/2016 10:30	72	0	46	0	105	21986	1	5388	2454
12/20/2016 10:31	76	0	45	0	103	22000	1	5240	2452
12/20/2016 10:32	75	0	47	0	104	21722	1	5339	2433
12/20/2016 10:33	75	0	49	0	103	21410	1	5267	2432
12/20/2016 10:34	50	0	48	0	103	21104	1	5262	2448
12/20/2016 10:35	50	0	48	0	103	20796	1	5253	2465
12/20/2016 10:36	51	0	48	0	102	20363	1	5269	2454
12/20/2016 10:37	49	0	47	0	101	20073	1	5320	2448
12/20/2016 10:38	73	0	44	0	99	19723	1	5243	2418
12/20/2016 10:39	113	0	44	0	97	19523	1	5257	2471
12/20/2016 10:40	71	0	42	0	97	19495	1	5283	2467
12/20/2016 10:41	47	0	44	0	98	19085	1	5271	2420
12/20/2016 10:42	78	0	42	0	95	18939	1	5252	2426
12/20/2016 10:43	109	0	41	0	95	18655	1	5406	2439
12/20/2016 10:44	96	0	43	0	93	18540	1	5332	2422
12/20/2016 10:45	77	0	42	0	94	18405	1	5275	2450
12/20/2016 10:46	75	0	40	0	94	18337	1	5334	2457
12/20/2016 10:47	50	0	41	0	92	17968	1	5298	2438
12/20/2016 10:48	50	0	38	0	88	17849	1	5256	2449
12/20/2016 10:49	50	0	39	0	93	18107	1	5268	2467
12/20/2016 10:50	80	0	44	0	94	19596	1	5298	2470
12/20/2016 10:51	76	0	44	0	101	21786	1	5305	2477
12/20/2016 10:52	68	0	47	0	100	21632	1	5269	2460
12/20/2016 10:53	69	0	45	0	99	21151	1	5330	2459
12/20/2016 10:54	74	0	46	0	95	20820	1	5268	2450
12/20/2016 10:55	75	0	44	0	98	2696	0	5350	2446
12/20/2016 10:56	75	0	54	0	106	29	0	5323	2433
12/20/2016 10:57	75	0	16535	0	91	0	1	5280	2439
12/20/2016 10:58	73	0	17132	0	88	18953	2	5322	2452
12/20/2016 10:59	72	0	19252	0	86	19336	2	5282	2446
12/20/2016 11:00	73	0	18426	0	86	18801	2	5316	2456
12/20/2016 11:01	71	0	19106	0	87	18307	2	5402	2446
12/20/2016 11:02	72	0	18909	0	87	18179	2	5296	2439
12/20/2016 11:03	110	0	17993	0	87	18279	2	5268	2445
12/20/2016 11:04	106	0	18825	0	86	17949	2	5345	2459
12/20/2016 11:05	97	0	16646	0	88	17907	2	5273	2426
12/20/2016 11:06	97	0	18504	0	88	17590	2	5329	2434
12/20/2016 11:07	97	0	16673	0	91	17645	2	5312	2451
12/20/2016 11:08	96	0	17841	0	97	4042	2	5267	2467
12/20/2016 11:09	99	0	17497	0	81	0	1	5296	2449

Date Time	Furnace Feed	Converter Blowing Rate					Number	Tower Acid Flow	
	TPH	SCFM					Converters	GPM	
	Feed	#1	#2	#3	#4	#5	Blowing	Interpass	Final
12/20/2016 11:10	102	0	16027	0	76	0	1	5290	2475
12/20/2016 11:11	99	0	356	0	97	22	0	5301	2488
12/20/2016 11:12	98	0	69	0	79	16769	1	5277	2478
12/20/2016 11:13	100	0	66	0	71	16695	1	5274	2450
12/20/2016 11:14	97	0	67	0	70	16659	1	5315	2480
12/20/2016 11:15	101	0	67	0	72	16472	1	5254	2471
12/20/2016 11:16	98	0	67	0	73	16253	1	5306	2487
12/20/2016 11:17	98	0	66	0	72	16209	1	5323	2463
12/20/2016 11:18	98	0	67	0	71	15913	1	5246	2443
12/20/2016 11:19	98	0	68	0	72	16484	1	5312	2437
12/20/2016 11:20	99	0	66	0	71	16152	1	5281	2459
12/20/2016 11:21	103	0	64	0	71	15848	1	5365	2482
12/20/2016 11:22	98	0	63	0	72	15519	1	5362	2399
12/20/2016 11:23	99	0	61	0	70	15474	1	5263	2403
12/20/2016 11:24	100	0	59	0	72	15002	1	5360	2438
12/20/2016 11:25	101	0	57	0	70	14954	1	5208	2457
12/20/2016 11:26	99	0	14667	0	76	14142	2	5266	2458
12/20/2016 11:27	100	0	12506	0	81	14730	2	5340	2478
12/20/2016 11:28	99	0	13050	0	79	14275	2	5344	2472
12/20/2016 11:29	100	0	17054	0	76	14053	2	5324	2434
12/20/2016 11:30	100	0	14573	0	77	14204	2	5311	2449
12/20/2016 11:31	100	0	15769	0	75	13970	2	5258	2459
12/20/2016 11:32	97	0	15310	0	77	13993	2	5368	2461
12/20/2016 11:33	98	0	11744	0	78	13840	2	5272	2478
12/20/2016 11:34	96	0	12957	0	74	13763	2	5287	2437
12/20/2016 11:35	100	0	17296	0	73	13850	2	5272	2455
12/20/2016 11:36	100	0	14616	0	77	15022	2	5351	2474
12/20/2016 11:37	101	0	16213	0	75	17306	2	5342	2478
12/20/2016 11:38	110	0	17419	0	70	17443	2	5348	2473
12/20/2016 11:39	104	0	14955	0	70	20077	2	5343	2469
12/20/2016 11:40	100	0	16518	0	68	19296	2	5231	2458
12/20/2016 11:41	102	0	16112	0	70	18858	2	5313	2481
12/20/2016 11:42	103	0	89	0	66	18320	1	5224	2469
12/20/2016 11:43	100	0	15304	0	69	17740	2	5302	2451
12/20/2016 11:44	100	0	17617	0	68	16795	2	5344	2433
12/20/2016 11:45	98	0	16976	0	67	17898	2	5310	2430
12/20/2016 11:46	101	0	18511	0	62	0	1	5346	2421
12/20/2016 11:47	100	0	16863	0	59	0	1	5412	2446
12/20/2016 11:48	99	0	178	0	58	16375	1	5312	2474
12/20/2016 11:49	72	0	14698	0	65	16072	2	5320	2482
12/20/2016 11:50	76	0	13980	0	67	15691	2	5311	2430
12/20/2016 11:51	76	0	19236	0	65	15703	2	5312	2461
12/20/2016 11:52	76	0	16664	0	67	14868	2	5267	2487
12/20/2016 11:53	70	0	17876	0	65	15310	2	5231	2472
12/20/2016 11:54	75	0	15876	0	65	15911	2	5273	2435
12/20/2016 11:55	74	0	18276	0	62	15479	2	5271	2434

Date Time	Furnace Feed	Converter Blowing Rate					Number	Tower Acid Flow	
	TPH	SCFM					Converters	GPM	
	Feed	#1	#2	#3	#4	#5	Blowing	Interpass	Final
12/20/2016 11:56	73	0	16870	0	63	16011	2	5209	2475
12/20/2016 11:57	75	0	16544	0	60	15573	2	5295	2462
12/20/2016 11:58	74	0	19046	0	57	15867	2	5241	2435
12/20/2016 11:59	75	0	16096	0	59	16485	2	5258	2456
12/20/2016 12:00	77	0	18856	0	59	16086	2	5269	2445
12/20/2016 12:01	74	0	2491	0	67	17340	1	5317	2426
12/20/2016 12:02	77	0	95	0	55	16365	1	5238	2471
12/20/2016 12:03	72	0	103	0	59	4104	1	5322	2443
12/20/2016 12:04	74	0	98	0	62	16604	1	5349	2423
12/20/2016 12:05	72	0	93	0	53	16053	1	5225	2460
12/20/2016 12:06	78	0	92	0	56	16382	1	5319	2452
12/20/2016 12:07	77	0	90	0	53	16536	1	5305	2447
12/20/2016 12:08	75	0	90	0	56	16587	1	5291	2439
12/20/2016 12:09	79	0	86	0	54	16567	1	5288	2469
12/20/2016 12:10	74	0	86	0	55	16612	1	5300	2415
12/20/2016 12:11	76	0	86	0	54	16678	1	5314	2454
12/20/2016 12:12	72	0	9387	0	55	6546	2	5304	2426
12/20/2016 12:13	75	0	16201	0	55	0	1	5334	2449
12/20/2016 12:14	73	0	15042	0	62	17261	2	5270	2455
12/20/2016 12:15	74	0	17877	0	61	16748	2	5340	2426
12/20/2016 12:16	74	0	20047	0	59	16367	2	5266	2430
12/20/2016 12:17	74	0	19684	0	58	16814	2	5293	2411
12/20/2016 12:18	75	0	18060	0	59	17352	2	5325	2438
12/20/2016 12:19	78	0	16429	0	59	17400	2	5249	2422
12/20/2016 12:20	75	0	3099	0	64	17996	1	5262	2478
12/20/2016 12:21	112	0	90	0	52	17288	1	5268	2443
12/20/2016 12:22	106	0	87	0	51	17477	1	5271	2439
12/20/2016 12:23	102	0	95	0	58	3517	1	5382	2443
12/20/2016 12:24	102	0	12869	0	53	1607	1	5259	2431
12/20/2016 12:25	101	0	92	0	54	16993	1	5313	2458
12/20/2016 12:26	74	0	87	0	51	18264	1	5354	2434
12/20/2016 12:27	107	0	88	0	60	20351	1	5282	2484
12/20/2016 12:28	102	0	89	0	62	20737	1	5324	2429
12/20/2016 12:29	100	0	89	0	60	20261	1	5304	2445
12/20/2016 12:30	76	0	76	0	13662	18211	2	5326	2468
12/20/2016 12:31	106	0	80	0	19342	18804	2	5306	2458
12/20/2016 12:32	103	0	84	0	16278	19100	2	5419	2452
12/20/2016 12:33	98	0	81	0	14477	19404	2	5341	2429
12/20/2016 12:34	94	0	82	0	15349	19239	2	5235	2462
12/20/2016 12:35	92	0	82	0	15115	19198	2	5289	2439
12/20/2016 12:36	95	0	82	0	11936	19511	2	5355	2447
12/20/2016 12:37	96	0	83	0	11106	18859	2	5301	2466
12/20/2016 12:38	97	0	84	0	11557	19081	2	5286	2459
12/20/2016 12:39	97	0	81	0	14791	18788	2	5366	2417
12/20/2016 12:40	97	0	80	0	14837	20794	2	5359	2422
12/20/2016 12:41	98	0	82	0	13508	20499	2	5236	2464

Date Time	Furnace Feed	Converter Blowing Rate					Number	Tower Acid Flow	
	TPH	SCFM					Converters	GPM	
	Feed	#1	#2	#3	#4	#5	Blowing	Interpass	Final
12/20/2016 12:42	100	0	85	0	9268	20380	2	5274	2466
12/20/2016 12:43	101	0	80	0	13080	19659	2	5328	2475
12/20/2016 12:44	101	0	80	0	16249	19341	2	5378	2434
12/20/2016 12:45	101	0	79	0	17296	19270	2	5326	2471
12/20/2016 12:46	102	0	81	0	17048	19445	2	5379	2465
12/20/2016 12:47	101	0	80	0	16497	19692	2	5300	2484
12/20/2016 12:48	101	0	84	0	18339	2002	1	5328	2428
12/20/2016 12:49	100	0	72	0	16377	0	1	5370	2490
12/20/2016 12:50	100	0	72	0	19063	0	1	5331	2491
12/20/2016 12:51	101	0	73	0	18342	0	1	5327	2449
12/20/2016 12:52	100	0	74	0	18660	0	1	5288	2447
12/20/2016 12:53	101	0	67	0	17090	0	1	5222	2453
12/20/2016 12:54	102	0	67	0	17536	0	1	5278	2458
12/20/2016 12:55	101	0	69	0	17807	0	1	5303	2427
12/20/2016 12:56	101	0	71	0	20003	0	1	5293	2417
12/20/2016 12:57	101	0	72	0	3380	4	1	5279	2478
12/20/2016 12:58	100	0	75	0	21	11	0	5295	2439
12/20/2016 12:59	99	0	78	0	6	10	0	5334	2452
12/20/2016 13:00	103	0	77	0	0	11	0	5258	2418
12/20/2016 13:01	103	0	76	0	0	11	0	5280	2464
12/20/2016 13:02	101	0	74	0	0	8	0	5232	2470
12/20/2016 13:03	98	0	75	0	0	9	0	5222	2456
12/20/2016 13:04	99	0	78	0	0	15	0	5287	2426
12/20/2016 13:05	99	0	81	0	0	13	0	5236	2455
12/20/2016 13:06	98	0	81	0	6	14	0	5237	2430
12/20/2016 13:07	100	0	78	0	11	14	0	5300	2430
12/20/2016 13:08	97	0	77	0	13	12	0	5250	2446
12/20/2016 13:09	102	0	80	0	20	13	0	5243	2429
12/20/2016 13:10	102	0	61	0	13881	10	1	5266	2391
12/20/2016 13:11	99	0	75	0	16223	6	1	5267	2407
12/20/2016 13:12	77	0	68	0	14167	0	1	5165	2431
12/20/2016 13:13	75	0	66	0	14231	0	1	5351	2414
12/20/2016 13:14	73	0	69	0	17057	0	1	5272	2418
12/20/2016 13:15	75	0	72	0	18132	0	1	5299	2444
12/20/2016 13:16	76	0	69	0	16555	0	1	5277	2426
12/20/2016 13:17	74	0	69	0	16563	0	1	5274	2435
12/20/2016 13:18	78	0	62	0	15583	0	1	5339	2432
12/20/2016 13:19	73	0	70	0	16708	0	1	5262	2456
12/20/2016 13:20	74	0	75	0	752	20783	1	5395	2479
12/20/2016 13:21	76	0	73	0	11	19813	1	5273	2464
12/20/2016 13:22	72	0	70	0	1	19655	1	5322	2459
12/20/2016 13:23	73	0	72	0	0	19801	1	5247	2452
12/20/2016 13:24	72	0	70	0	0	19808	1	5344	2468
12/20/2016 13:25	75	0	11740	0	0	19741	2	5222	2454
12/20/2016 13:26	72	0	11338	0	0	20118	2	5342	2448
12/20/2016 13:27	78	0	16396	0	0	17696	2	5341	2454

Date Time	Furnace Feed	Converter Blowing Rate					Number	Tower Acid Flow	
	TPH	SCFM					Converters	GPM	
	Feed	#1	#2	#3	#4	#5	Blowing	Interpass	Final
12/20/2016 13:28	75	0	21317	0	0	17557	2	5310	2498
12/20/2016 13:29	73	0	19996	0	0	18647	2	5310	2464
<b>14:14 to 18:25</b>									
12/20/2016 14:15	105	0	20222	0	43	0	1	5323	2476
12/20/2016 14:16	98	0	20222	0	41	0	1	5319	2470
12/20/2016 14:17	99	0	20122	0	42	0	1	5290	2434
12/20/2016 14:18	104	0	19782	0	43	0	1	5281	2452
12/20/2016 14:19	97	0	19776	0	40	0	1	5351	2478
12/20/2016 14:20	99	0	19508	0	40	0	1	5302	2465
12/20/2016 14:21	99	0	19553	0	39	0	1	5311	2474
12/20/2016 14:22	99	0	19280	0	38	0	1	5316	2444
12/20/2016 14:23	101	0	19421	0	40	0	1	5296	2474
12/20/2016 14:24	102	0	19098	0	41	0	1	5265	2457
12/20/2016 14:25	99	0	19231	0	40	0	1	5295	2467
12/20/2016 14:26	99	0	19207	0	36	0	1	5298	2480
12/20/2016 14:27	101	0	19455	0	37	0	1	5250	2441
12/20/2016 14:28	105	0	19136	0	38	0	1	5355	2482
12/20/2016 14:29	97	0	19290	0	34	0	1	5398	2451
12/20/2016 14:30	94	0	19221	0	37	0	1	5348	2462
12/20/2016 14:31	99	0	18994	0	37	0	1	5286	2458
12/20/2016 14:32	101	0	19110	0	36	0	1	5334	2464
12/20/2016 14:33	98	0	18871	0	35	0	1	5288	2450
12/20/2016 14:34	99	0	19033	0	37	0	1	5359	2458
12/20/2016 14:35	96	0	18786	0	40	0	1	5228	2463
12/20/2016 14:36	99	0	18970	0	39	0	1	5281	2461
12/20/2016 14:37	98	0	19008	0	39	0	1	5304	2460
12/20/2016 14:38	102	0	19062	0	40	0	1	5295	2480
12/20/2016 14:39	103	0	18987	0	38	0	1	5360	2421
12/20/2016 14:40	102	0	18936	0	38	0	1	5254	2448
12/20/2016 14:41	100	0	19012	0	39	0	1	5260	2472
12/20/2016 14:42	101	0	19158	0	13639	11	2	5305	2404
12/20/2016 14:43	97	0	8707	0	10965	2	2	5357	2499
12/20/2016 14:44	99	0	106	0	468	20	0	5266	2463
12/20/2016 14:45	99	0	112	0	78	23	0	5285	2488
12/20/2016 14:46	96	0	109	0	76	22	0	5302	2471
12/20/2016 14:47	100	0	112	0	75	23	0	5313	2449
12/20/2016 14:48	98	0	115	0	77	23	0	5351	2429
12/20/2016 14:49	98	0	110	0	75	25	0	5264	2422
12/20/2016 14:50	97	0	110	0	75	26	0	5265	2430
12/20/2016 14:51	100	0	107	0	72	25	0	5237	2403
12/20/2016 14:52	95	0	112	0	73	26	0	5271	2418
12/20/2016 14:53	98	0	91	0	8365	17	1	5262	2456
12/20/2016 14:54	102	0	91	0	10038	10	1	5232	2446
12/20/2016 14:55	97	0	88	0	10053	13	1	5307	2483

Date Time	Furnace Feed	Converter Blowing Rate					Number	Tower Acid Flow	
	TPH	SCFM					Converters	GPM	
	Feed	#1	#2	#3	#4	#5	Blowing	Interpass	Final
12/20/2016 14:56	101	0	88	0	9857	15	1	5302	2449
12/20/2016 14:57	98	0	17335	0	10130	12	2	5345	2417
12/20/2016 14:58	104	0	17721	0	12585	11	2	5256	2461
12/20/2016 14:59	96	0	17806	0	14907	12	2	5262	2449
12/20/2016 15:00	107	0	17868	0	17209	7	2	5308	2453
12/20/2016 15:01	104	0	17904	0	18377	11	2	5314	2431
12/20/2016 15:02	75	0	18150	0	2941	1624	2	5324	2445
12/20/2016 15:03	71	0	17978	0	77	370	1	5267	2450
12/20/2016 15:04	74	0	17638	0	64	0	1	5321	2417
12/20/2016 15:05	76	0	17735	0	62	0	1	5327	2443
12/20/2016 15:06	72	0	17474	0	62	0	1	5373	2423
12/20/2016 15:07	78	0	17155	0	16341	11	2	5385	2450
12/20/2016 15:08	105	0	18106	0	16458	17	2	5314	2467
12/20/2016 15:09	100	0	16539	0	15133	18	2	5293	2483
12/20/2016 15:10	103	0	16453	0	15066	18	2	5289	2467
12/20/2016 15:11	100	0	16488	0	15112	17	2	5299	2489
12/20/2016 15:12	99	0	16390	0	14083	17	2	5265	2475
12/20/2016 15:13	94	0	16198	0	14249	18	2	5286	2473
12/20/2016 15:14	102	0	16675	0	15092	18	2	5355	2424
12/20/2016 15:15	101	0	16581	0	16228	13	2	5330	2429
12/20/2016 15:16	96	0	16636	0	14965	15	2	5281	2438
12/20/2016 15:17	100	0	17605	0	14999	13	2	5360	2429
12/20/2016 15:18	104	0	17498	0	16432	12	2	5242	2450
12/20/2016 15:19	100	0	17191	0	13971	16	2	5333	2464
12/20/2016 15:20	98	0	17245	0	15568	10	2	5324	2484
12/20/2016 15:21	103	0	17469	0	13296	15	2	5264	2488
12/20/2016 15:22	98	0	17751	0	10113	14	2	5306	2450
12/20/2016 15:23	98	0	17533	0	8040	11	2	5282	2501
12/20/2016 15:24	97	0	17890	0	10526	9	2	5348	2450
12/20/2016 15:25	98	0	18168	0	13884	11	2	5261	2463
12/20/2016 15:26	102	0	18460	0	14691	10	2	5299	2424
12/20/2016 15:27	96	0	11095	0	10674	4	2	5321	2454
12/20/2016 15:28	101	0	109	0	10248	0	1	5347	2441
12/20/2016 15:29	101	0	111	0	14000	0	1	5418	2460
12/20/2016 15:30	98	0	118	0	8212	0	1	5274	2460
12/20/2016 15:31	101	0	129	0	0	28	0	5304	2423
12/20/2016 15:32	101	0	123	0	0	15	0	5381	2477
12/20/2016 15:33	96	0	118	0	0	22	0	5351	2444
12/20/2016 15:34	103	0	119	0	0	20	0	5313	2462
12/20/2016 15:35	104	0	17930	0	0	14	1	5221	2418
12/20/2016 15:36	97	0	18549	0	0	0	1	5278	2475
12/20/2016 15:37	100	0	18334	0	0	0	1	5293	2399
12/20/2016 15:38	101	0	17868	0	0	0	1	5327	2402
12/20/2016 15:39	70	0	17109	0	0	0	1	5300	2395
12/20/2016 15:40	72	0	17150	0	0	0	1	5289	2442
12/20/2016 15:41	74	0	17005	0	0	0	1	5288	2477

Date Time	Furnace Feed	Converter Blowing Rate					Number	Tower Acid Flow	
	TPH	SCFM					Converters	GPM	
	Feed	#1	#2	#3	#4	#5	Blowing	Interpass	Final
12/20/2016 15:42	73	0	16541	0	0	0	1	5321	2443
12/20/2016 15:43	74	0	16914	0	0	0	1	5299	2483
12/20/2016 15:44	74	0	16634	0	0	0	1	5369	2440
12/20/2016 15:45	75	0	16713	0	0	0	1	5345	2462
12/20/2016 15:46	75	0	16578	0	0	0	1	5274	2464
12/20/2016 15:47	74	0	15919	0	0	0	1	5300	2436
12/20/2016 15:48	73	0	17253	0	0	0	1	5335	2470
12/20/2016 15:49	72	0	16752	0	12302	12	2	5313	2430
12/20/2016 15:50	73	0	16579	0	9852	12	2	5320	2413
12/20/2016 15:51	72	0	15688	0	10854	14	2	5346	2459
12/20/2016 15:52	72	0	17481	0	16465	11	2	5276	2464
12/20/2016 15:53	111	0	18893	0	17188	15	2	5334	2430
12/20/2016 15:54	102	0	20756	0	15926	8	2	5216	2460
12/20/2016 15:55	102	0	20249	0	17420	11	2	5239	2449
12/20/2016 15:56	102	0	20550	0	14523	13	2	5374	2421
12/20/2016 15:57	100	0	20477	0	11347	13	2	5271	2433
12/20/2016 15:58	100	0	19952	0	15097	13	2	5321	2430
12/20/2016 15:59	99	0	19687	0	16434	9	2	5281	2447
12/20/2016 16:00	98	0	19835	0	13285	6	2	5282	2470
12/20/2016 16:01	98	0	19651	0	14530	11	2	5402	2435
12/20/2016 16:02	98	0	19399	0	14314	10	2	5375	2476
12/20/2016 16:03	100	0	19574	0	16495	14	2	5328	2439
12/20/2016 16:04	101	0	19952	0	14292	12	2	5377	2466
12/20/2016 16:05	100	0	19788	0	15980	10	2	5326	2448
12/20/2016 16:06	100	0	19527	0	12201	17	2	5248	2484
12/20/2016 16:07	98	0	540	0	12241	0	1	5337	2427
12/20/2016 16:08	101	0	119	0	14631	0	1	5227	2488
12/20/2016 16:09	98	0	114	0	15194	0	1	5277	2458
12/20/2016 16:10	99	0	121	0	4925	0	1	5285	2463
12/20/2016 16:11	98	0	135	0	0	28	0	5268	2472
12/20/2016 16:12	95	0	125	0	0	24	0	5308	2424
12/20/2016 16:13	100	0	126	0	0	23	0	5229	2413
12/20/2016 16:14	98	0	126	0	0	25	0	5318	2401
12/20/2016 16:15	100	0	116	0	11056	18	1	5238	2423
12/20/2016 16:16	100	0	19312	0	11398	10	2	5327	2459
12/20/2016 16:17	100	0	18490	0	16824	5	2	5382	2431
12/20/2016 16:18	99	0	17964	0	17393	13	2	5284	2442
12/20/2016 16:19	100	0	15569	0	9259	14	2	5253	2432
12/20/2016 16:20	100	0	13446	0	0	27	1	5276	2443
12/20/2016 16:21	100	0	1434	0	0	20	0	5299	2409
12/20/2016 16:22	75	0	122	0	0	28	0	5217	2448
12/20/2016 16:23	73	0	112	0	0	21	0	5212	2477
12/20/2016 16:24	75	0	107	0	0	26	0	5315	2443
12/20/2016 16:25	75	0	113	0	0	23	0	5309	2448
12/20/2016 16:26	73	0	110	0	0	26	0	5272	2425
12/20/2016 16:27	75	0	108	0	0	26	0	5305	2477





Date Time	Furnace Feed	Converter Blowing Rate					Number	Tower Acid Flow	
	TPH	SCFM					Converters	GPM	
	Feed	#1	#2	#3	#4	#5	Blowing	Interpass	Final
12/20/2016 18:00	99	0	71	0	18411	0	1	5365	2460
12/20/2016 18:01	95	0	71	0	18287	0	1	5368	2465
12/20/2016 18:02	101	0	70	0	17863	0	1	5341	2463
12/20/2016 18:03	102	0	69	0	17438	0	1	5301	2434
12/20/2016 18:04	98	0	69	0	16859	0	1	5316	2449
12/20/2016 18:05	103	0	72	0	16648	0	1	5330	2458
12/20/2016 18:06	100	0	68	0	16231	0	1	5313	2478
12/20/2016 18:07	101	0	67	0	15600	0	1	5357	2454
12/20/2016 18:08	99	0	64	0	15380	0	1	5294	2475
12/20/2016 18:09	101	0	58	0	14935	0	1	5315	2470
12/20/2016 18:10	98	0	56	0	14526	0	1	5281	2464
12/20/2016 18:11	98	0	52	0	13828	0	1	5251	2467
12/20/2016 18:12	98	0	48	0	13622	0	1	5284	2450
12/20/2016 18:13	94	0	56	0	13100	0	1	5255	2453
12/20/2016 18:14	103	0	58	0	12712	0	1	5340	2441
12/20/2016 18:15	101	0	55	0	12038	0	1	5310	2432
12/20/2016 18:16	104	0	60	0	11683	0	1	5350	2474
12/20/2016 18:17	100	0	60	0	10781	2	1	5326	2428
12/20/2016 18:18	75	0	70	0	10363	14	1	5331	2441
12/20/2016 18:19	74	0	67	0	10106	18	1	5314	2460
12/20/2016 18:20	75	0	59	0	11786	0	1	5217	2461
12/20/2016 18:21	76	0	62	0	14985	0	1	5299	2437
12/20/2016 18:22	75	0	68	0	20113	0	1	5247	2425
12/20/2016 18:23	74	0	69	0	20263	0	1	5374	2481
12/20/2016 18:24	77	0	70	0	18182	0	1	5251	2406
12/20/2016 18:25	76	0	66	0	16203	0	1	5299	2424

# EPA Methods 1-5

## Gas Flow/Moisture/Particulate/Example Calculation

Company Name: ASARCO  
 Plant Location: HAYDEN, AZ  
 Source Tested: ACID PLANT

Run: 1 PT  
 Test Date: 12/19/16

$$P_m''\text{Hg} = 28.11 \text{ P}_b''\text{Hg} + (2.334 \Delta H''\text{H}_2\text{O}/13.6) = 28.282 \text{ P}_m''\text{Hg}$$

$$P_s''\text{Hg} = 28.11 \text{ P}_b''\text{Hg} + (-0.81 \text{ Static }''\text{H}_2\text{O}/13.6) = 28.050 \text{ P}_s''\text{Hg}$$

$$1a) V_{m(\text{std})\text{dscf}} = (208.505 V_m) (17.65) (0.9976) \left( \frac{28.282 \text{ P}_m''\text{Hg}}{533.3 \text{ Tm}^\circ\text{A}} \right) = 194.696 \text{ dscf}$$

$$1b) V_{m(\text{std})\text{dscm}} = (194.696) V_{m(\text{std})\text{dscf}} (0.0283168) = 5.513 \text{ dscm}$$

$$2) V_{w(\text{std})} = (0.04707) (2.8 \text{ ml}) = 0.132 \text{ scf}$$

$$3) B_{ws} = \left( \frac{0.132 \text{ scf}}{0.132 \text{ scf} + 194.696 \text{ dscf}} \right) = 0.0007 B_{ws} \times 100 = 0.07 \% \text{H}_2\text{O}$$

$$4) V_{m(\text{actual})} = \left( \frac{(0.9976)(208.505 V_m)}{(1 - 0.0007 B_{ws})} \right) \left( \frac{751.6 \text{ Tm}^\circ\text{A}}{533.3 \text{ Tm}^\circ\text{A}} \right) \left( \frac{28.282 \text{ P}_m''\text{Hg}}{28.050 \text{ P}_s''\text{Hg}} \right) = 295.780 \text{ awcf}$$

$$5) M_d = 0.44 \left( \frac{0.28}{A} \% \text{CO}_2 \right) + 0.32 \left( \frac{13.94}{B} \% \text{O}_2 \right) + 0.28 \left( \frac{85.78}{100-(A+B)} \% \text{N}_2 + \% \text{CO} \right) = 28.60 \text{ lb/lb mole}$$

$$6) M_s = (28.60 \text{ lb/lb mole}) (1 - 0.0007 B_{ws}) + (18 \times 0.0007 B_{ws}) = 28.59 \text{ lb/lb mole}$$

$$7a) \text{Stack Area} = (3.1416) \left( \frac{8.167}{\text{diameter}} \text{ ft./2} \right)^2 = 52.386 \text{ sq. ft.}$$

$$7b) \text{Stack Area} = (\text{ft.})(\text{ft.}) = \text{sq. ft.}$$

$$8) V_s = (85.49) (0.84 \text{ cp}) (0.6589 \text{ Avg. SQRT } \Delta P) \left( \sqrt{\frac{751.6 \text{ Tm}^\circ\text{A}}{(28.050 \text{ P}_s''\text{Hg})(28.59 \text{ lb/lbmole})}} \right) = 45.81 \text{ fps}$$

$$9a) \text{AWCFM} = (45.81 \text{ fps}) (52.386 \text{ sq. ft.}) (60 \text{ sec/min}) = 143,988.2 \text{ AWCFM}$$

$$9b) \text{ADCFM} = (143,988.2 \text{ AWCFM}) (1 - 0.0007 B_{ws}) = 143,887.4 \text{ ADCFM}$$

# EPA Methods 1-5

## Gas Flow/Moisture/Particulate/Example Calculation

Company Name: ASARCO  
 Plant Location: HAYDEN AZ  
 Source Tested: ACID PLANT

Run: 1 PT  
 Test Date: 12/19/16

$$10a) Q_{sw} = 3600 \left( \frac{45.81 \text{ fps}}{52.386 \text{ sq. ft.}} \right) \left( \frac{528^{\circ} A}{751.6 T_{s^{\circ}} A} \right) \left( \frac{28.050 \text{ Ps}^{\prime\prime} \text{ Hg}}{29.92 \text{ " Hg}} \right) = 5,689,792.9 \text{ wsfcf/hr (1)}$$

$$10b) Q_{sd} = (1 - 0.0007 B_{ws}) (5,689,792.9 \text{ wsfcf/hr}) = 5,685,810.0 \text{ dscf/hr (1)}$$

### Particulate

$$11a) Cs = \frac{0.0092 \text{ grams}}{194.696 \text{ dscf}} (15.43 \text{ grains/gram}) = 0.0006 \text{ grains/dscf (4)}$$

$$11b) Cs = \frac{0.0092 \text{ grams}}{295.780 \text{ awcf}} (15.43 \text{ grains/gram}) = 0.0004 \text{ grains/awcf (4)}$$

$$11c) Cs = \frac{0.0092 \text{ grams}}{5.513 \text{ dscm}} (1000 \text{ mg/gram}) = 1.31 \text{ mg/dscm (4)}$$

$$12) ME = \frac{(0.00057 \text{ dscf})(5,685,810.0 \text{ dscf/hr})}{7000 \text{ gr/lb}} = 0.46 \text{ lb/hr (2)}$$

$$13) \text{Area Nozzle} = (3.1416) \frac{(0.2860 \text{ in./24})^2}{\text{Nozzle diam } (3)} = 0.000446 \text{ Nz sq. ft. (6)}$$

$$14) \%I = \frac{(0.0945)(951.6 T_{s^{\circ}} A)(194.696 \text{ dscf})}{(28.050 \text{ Ps}^{\prime\prime} \text{ Hg})(45.81 \text{ fps})(0.000446 \text{ Nz sq. ft.})(240 \text{ min})(1 - 0.0007 B_{ws})} = 100.6 \text{ % Isokinetic (1)}$$

**EPA Methods 1-4, 5b****Field Data and Calculations****Particulate Emissions and Gas Stream Characteristics**

Client: ASARCO LLC - Hayden Operations

Run: 1-PT

Location: Hayden, Arizona

Time: 12:48-17:05

Source: Hayden Smelter - Acid Plant (S2)

Date: 12/19/16

Sampling Data				Traverse Data			
Time min.	Meter ft <sup>3</sup>	ΔH "H <sub>2</sub> O	Meter T <sub>m</sub> °F	Traverse Point	Dp "H <sub>2</sub> O	Stack T <sub>s</sub> °F	√Dp
20	867.335	2.07	63	1	0.41	315	0.640
40	883.661	1.99	67	2	0.39	315	0.624
60	899.600	2.13	69	3	0.40	281	0.632
80	916.200	2.03	71	4	0.38	281	0.616
100	932.500	1.93	73	5	0.36	282	0.600
120	948.400	1.97	75	6	0.33	283	0.574
20	963.765	2.26	76	1	0.42	282	0.648
40	981.000	3.15	77	2	0.59	290	0.768
60	1,001.400	2.72	77	3	0.51	290	0.714
80	1,020.400	2.56	77	4	0.48	291	0.693
100	1,038.800	2.87	77	5	0.54	294	0.735
120	1,058.200	2.33	77	6	0.44	295	0.663
	1,075.840						

**Client:** ASARCO LLC - Hayden Operations  
**Source:** Hayden Smelter - Acid Plant (S2)

**Run:** 1-PT  
**Date:** 12/19/16

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### Field Data Input: (Continued)

<u>Traverse Data</u>		<u>Stack Dimensional Data:</u>	
Barometric Pressure, P <sub>b</sub>	28.11 "Hg	Circular	
Static Pressure	-0.81 "H <sub>2</sub> O	Diameter	8.167 ft
Pitot Factor, cp	0.84	Rectangular	
Meter Cal Factor	0.9976 Y	Width	0.000 ft
		Length	0.000 ft
<u>Moisture Data</u>		Stack Area	52.386 sq.ft.
Total Test Time	240 min		
Sample Time Interval	20 min	<u>EPA Method 3A</u>	
Meter Volume, V <sub>m</sub>	208.505 dcf	CO <sub>2</sub> Average	0.28 %vd
Water Volume	2.8 ml (g)	O <sub>2</sub> Average	13.94 %vd
Nozzle Diameter, N <sub>z</sub>	0.2860 sq.in.		
Nozzle Area	0.000446 sq.ft.	<u>EPA Method 5</u>	
		Wt. PT Collected	0.0072 grams

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### Field Data Averages

<u>Meter</u>	<u>Stack</u>
ΔH	/Dp
Temperature, T <sub>m</sub>	Temperature, T <sub>s</sub>
Temperature, T <sub>m</sub>	Temperature, T <sub>s</sub>
Pressure Meter, P <sub>m</sub>	Pressure Stack, P <sub>s</sub>

---

### Field Data Calculations

#### EPA Method 4 Meter Box Capture

Standard Volume, V <sub>m(std)</sub>	194.696 dscf
	5.513 dscm

Actual Volume, V <sub>m(actual)</sub>	295.780 awcf
---------------------------------------	--------------

#### EPA Method 4 Gas Stream Moisture

Moisture Vapor, V <sub>w(std)</sub>	0.132 scf
-------------------------------------	-----------

Moisture, B <sub>ws</sub>	0.0007
---------------------------	--------

Percent Moisture	0.07 %v
------------------	---------

#### EPA Method 3 Gas Density

Dry, M <sub>d</sub>	28.60 lb/lb-mole
---------------------	------------------

Wet, M <sub>s</sub>	28.59 lb/lb-mole
---------------------	------------------

#### EPA Method 2 Stack Gas Flowrate:

Velocity, V <sub>s</sub>	45.81 fps
Volume (actual)	143,988.2 awcfm

	143,887.4 adcfm
--	-----------------

Volume (standard)	5,689,792.9 wscf/hr
	5,685,810.0 dscf/hr

#### EPA Method 5 Particulate Emissions:

Concentration, C <sub>s</sub>	0.000571 gr/dscf
Concentration, gr/awcf	0.000376 gr/awcf

	1.31 mg/dscm
--	--------------

Mass Emissions	0.46 lb/hr
----------------	------------

Percent Isokinetic	100.6 %
--------------------	---------



## MOISTURE DETERMINATION



Company Name:	ASARCO	Run:	1
Plant Location:	Hayden AZ	Test Date:	10/19/16
Source Tested:	Acid Plant (outlets)	Start Time:	1248
Weighed By:	JS	Balance Level:	Balance Zeroed:
			End Time: 1705

WEIGHT (Grams)

## Impinger 1:

Final Weight: 679.7  
 Initial Weight: 705.8  
 Weight Gain: -26.1

Liquid Appearance: (clear, cloudy, dark etc.)  
 Impinger caddy color Grey  
 Filter ID: 8  
 Probe Length: ④ 11  
 Probe Material: GL

## Impinger 2:

Final Weight: 708.2  
 Initial Weight: 726.0  
 Weight Gain: -17.8

1090  
 H2O2

## Impinger 3:

Final Weight: 697.0  
 Initial Weight: 698.3  
 Weight Gain: -1.3

1090  
 H2O2

## Impinger 4: (if applicable)

Final Weight: 585.7  
 Initial Weight: 580.4  
 Weight Gain: +5.3

Empty

## Impinger 5: (if applicable)

Final Weight:  
 Initial Weight:  
 Weight Gain:

## Silica Gel Impinger:

Final Weight: 1012.7  
 Initial Weight: 970.0  
 Weight Gain: +42.7

Silica Gel  
 Spent  
 (please  
 circle)  
 Yes / No

Total Mass of Water Captured: +54.8 grams (ml)

## Notes

74.0  
 2.8

EEMCFILES/ReportResources/Forms:Revised 10/22/14kr

## Particulate Laboratory Data

COMPANY NAME:  
LOCATION:  
SOURCE:

ASARCO  
Hayden, AZ  
Acid pH Dust

RUN: L-PT  
DATE: Test 12/19/16  
METHOD: 56

Filter 8-M			
Tare Weights			
	Weight	Date	Time
Filter 8-M			
1	2763	12/14/16	0900
2	2764	15	0800
3	2764	16	0800
Average	2764	—	—

Probe 4B			
Tare Weights in Wash			
	Weight	Date	Time
Wash			
1	91.4559	12/14/16	0900
2	91.4562	15	0800
3	91.4560	16	0800
Average	91.4560	—	—

Filter Appearance: Light gray

Wash Appearance: Slight black specks  
Acetone Wash Volume: 125 mL

## Sample Weights

Probe Wash			
Beaker/Dish/Run: 4B			
Description: 110cm			
	Weight	Date	Time
1	91.4560	12/22/16	0900
2	91.4593	23	0900
3	91.4596	27	0900
Final Weight Average:	91.4597	—	—
Tare Weight:	91.4560	—	—
Net Weight:	.0037	—	—

Filter Catch			
	Weight	Date	Time
1	2800	12/22/16	0900
2	2798	23	0900
3	2799	27	0900
Final Weight Average:	2799	—	—
Tare Weight:	2764	—	—
Net Weight:	.0035	—	—

$$\% \text{ Delta} = ((\text{Net Wt} - \text{Audit Value}) / \text{audit value}) * 100$$

$$\% \text{ Delta} = .1998 - .1475 = .0523$$

Probe and Cyclone Residue .0037 g - .0000 g (blank) = .0037 g ✓ 1/2 .0523 Δ = 00%

Impinger Residue \_\_\_\_\_ g - \_\_\_\_\_ g (blank) = \_\_\_\_\_ g

= .0072 g ✓

= \_\_\_\_\_ g

EPA Method (Filter, Probe & Cyclone Residue)

Particulate Weight (including impingers)

Notes: \_\_\_\_\_

**EPA Methods 1-4, 5b****Field Data and Calculations****Particulate Emissions and Gas Stream Characteristics**

**Client:** ASARCO LLC - Hayden Operations  
**Location:** Hayden, Arizona  
**Source:** Hayden Smelter - Acid Plant (S2)

**Run:** 2-PT  
**Time:** 08:28-13:29\*  
**Date:** 12/20/16

\*Run Interrupted

Sampling Data				Traverse Data			
Time min.	Meter ft <sup>3</sup>	ΔH "H <sub>2</sub> O	Meter T <sub>m</sub> °F	Traverse Point	Dp "H <sub>2</sub> O	Stack T <sub>s</sub> °F	√Dp
20	1,078.525	2.49	63	1	0.50	279	0.707
40	1,094.200	2.74	70	2	0.55	289	0.742
60	1,113.100	2.44	69	3	0.49	290	0.700
80	1,130.900	2.29	68	4	0.46	289	0.678
100	1,148.100	1.81	66	5	0.36	277	0.600
120	1,163.400	2.01	67	6	0.40	279	0.632
20	1,179.615	2.82	69	1	0.55	268	0.742
40	1,198.200	2.96	71	2	0.59	285	0.768
60	1,218.400	2.91	72	3	0.58	287	0.762
80	1,237.900	2.47	73	4	0.48	271	0.693
100	1,255.900	3.17	73	5	0.63	288	0.794
120	1,276.300	2.71	74	6	0.54	291	0.735
	1,295.150						

**Client:** ASARCO LLC - Hayden Operations      **Run:** 2-PT  
**Source:** Hayden Smelter - Acid Plant (S2)      **Date:** 12/20/16

### Field Data Input: (Continued)

<u>Traverse Data</u>		<u>Stack Dimensional Data:</u>		
Barometric Pressure, P <sub>b</sub>	28.13 "Hg	Circular		
Static Pressure	-0.71 "H <sub>2</sub> O	Diameter		8.167 ft
Pitot Factor, cp	0.84	Rectangular		
Meter Cal Factor	0.9976 Y	Width		0.000 ft
		Length		0.000 ft
		Stack Area		52.386 sq.ft.
<u>Moisture Data</u>				
Total Test Time	240 min			
Sample Time Interval	20 min	<u>EPA Method 3A</u>		
Meter Volume, V <sub>m</sub>	216.625 dcf	CO <sub>2</sub> Average		0.30 %vd
Water Volume	1.1 ml (g)	O <sub>2</sub> Average		14.89 %vd
Nozzle Diameter, N <sub>z</sub>	0.2820 sq.in.	<u>EPA Method 5</u>		
Nozzle Area	0.000434 sq.ft.	Wt. PT Collected		0.0055 grams

### Field Data Averages

<u>Meter</u>	<u>Stack</u>
ΔH	2.568 "H <sub>2</sub> O /Dp
Temperature, T <sub>m</sub>	69.6 °F Temperature, T <sub>s</sub>
Temperature, T <sub>m</sub>	529.6 °A (°R) Temperature, T <sub>s</sub>
Pressure Meter, P <sub>m</sub>	28.319 "Hg Pressure Stack, P <sub>s</sub>

### Field Data Calculations

<u>EPA Method 4 Meter Box Capture</u>		<u>EPA Method 2 Stack Gas Flowrate:</u>	
Standard Volume, V <sub>m(std)</sub>	203.957 dscf	Velocity, V <sub>s</sub>	49.20 fps
Actual Volume, V <sub>m(actual)</sub>	305.795 awcf	Volume (actual)	154,643.5 awcfm
<u>EPA Method 4 Gas Stream Moisture</u>		Volume (standard)	154,597.1 adcfm
Moisture Vapor, V <sub>w(std)</sub>	0.052 scf		6,189,412.8 wscf/hr
Moisture, B <sub>ws</sub>	0.0003		6,187,556.0 dscf/hr
Percent Moisture	0.03 %v	<u>EPA Method 5 Particulate Emissions:</u>	
		Concentration, C <sub>s</sub>	0.0004 gr/dscf
		Concentration, gr/awcf	0.0003 gr/awcf
<u>EPA Method 3 Gas Density</u>		Mass Emissions	0.35 lb/hr
Dry, M <sub>d</sub>	28.64 lb/lb-mol		
Wet, M <sub>s</sub>	28.64 lb/lb-mole	Percent Isokinetic	99.5 %



## MOISTURE DETERMINATION



Company Name:	ASARCO	Run:	Q
Plant Location:	Hayden, AZ	Test Date:	12/20/16
Source Tested:	Acid Plant	Start Time:	0828
Weighed By:	JB	Balance Level:	✓
		Balance Zeroed:	✓
		End Time:	1329

WEIGHT (Grams)

## Impinger 1:

Final Weight: 636.7  
 Initial Weight: 671.4  
 Weight Gain: -34.7

Liquid H<sub>2</sub>O<sub>2</sub>  
 Appearance: (clear, cloudy, dark etc.)  
 Impinger caddy color \_\_\_\_\_

Filter ID: 14  
 Probe Length: 10  
 Probe Material: Glass

## Impinger 2:

Final Weight: 680.6  
 Initial Weight: 692.8  
 Weight Gain: -12.2

H<sub>2</sub>O<sub>2</sub>

## Impinger 3:

Final Weight: 679.5  
 Initial Weight: 680.5  
 Weight Gain: -1.0

H<sub>2</sub>O<sub>2</sub>

## Impinger 4: (if applicable)

Final Weight: 613.1  
 Initial Weight: 607.0  
 Weight Gain: 6.1

EMPTY

## Impinger 5: (if applicable)

Final Weight:  
 Initial Weight:  
 Weight Gain:

## Silica Gel Impinger:

Final Weight: 1034.7  
 Initial Weight: 991.8  
 Weight Gain: 42.9

Silica Gel  
Spent  
(please  
circle)

Yes / No

Total Mass of Water Captured: 1.10 grams (ml)

## Notes

## Particulate Laboratory Data

COMPANY NAME: ASARCO  
 LOCATION: 1104 Qen, AF  
 SOURCE: 0010 pt. Duct

RUN: 2-AF  
 DATE: Tue 12/14/16  
 METHOD: 56

Filter 14-W

## Tare Weights

Filter <u>14-W</u>	Weight	Date	Time
1	.2774	12/14/16	0900
2	.2776	15	0800
3	.2777	16	0800
Average	.2776	—	—

Filter Appearance: Light Gray

Probe

## Tare Weights in Wash

Wash	Weight	Date	Time
1	.893233	12/14/16	0900
2	.893234	15	0800
3	.893229	16	0800
Average	.893232	—	—

Wash Appearance: light black specks  
Acetone Wash Volume: 125 ml

## Sample Weights

Probe Wash	Weight	Date	Time
Beaker/Dish/Run:			
Description: <u>14-W-A</u>			
1	.893064	12/22/16	0900
2	.893061	23	0900
3	.893065	27	0900
Final Weight Average:	.893065	—	—
Tare Weight:	.893032	—	—
Net Weight:	.0031	—	—

Filter Catch	Weight	Date	Time
1	.2801	12/22/16	0900
2	.2800	23	0900
3	.2801	27	0900
Final Weight Average:	.2800	—	—
Tare Weight:	.2776	—	—
Net Weight:	.0024	—	—

$$\% \text{ Delta} = ((\text{Net Wt} - \text{Audit Value}) / \text{audit value}) * 100$$

See Run #1

Probe and Cyclone Residue .0031 g - .0000 g (blank) = .0031 g ✓Impinger Residue — g - — g (blank) = — gEPA Method (Filter, Probe & Cyclone Residue) = .0055 g ✓Particulate Weight (including impingers) = — g

Notes: \_\_\_\_\_

**EPA Methods 1-4, 5b****Field Data and Calculations****Particulate Emissions and Gas Stream Characteristics**

Client:	ASARCO LLC - Hayden Operations	Run:	3-PT
Location:	Hayden, Arizona	Time:	14:14-18:25
Source:	Hayden Smelter - Acid Plant (S2)	Date:	12/20/16

Sampling Data				Traverse Data			
Time min.	Meter ft <sup>3</sup>	ΔH °H <sub>2</sub> O	Meter T <sub>m</sub> °F	Traverse Point	D <sub>p</sub> °H <sub>2</sub> O	Stack T <sub>s</sub> °F	√D <sub>p</sub>
20	1,295.645	2.47	73	1	0.49	286	0.700
40	1,313.600	2.66	74	2	0.53	291	0.728
60	1,332.300	2.75	75	3	0.55	290	0.742
80	1,351.300	2.72	75	4	0.54	289	0.735
100	1,370.200	2.45	75	5	0.49	295	0.700
120	1,388.100	2.02	77	6	0.40	290	0.632
20	1,404.510	2.80	76	1	0.55	283	0.742
40	1,423.700	2.50	77	2	0.49	282	0.700
60	1,441.800	2.26	77	3	0.44	277	0.663
80	1,459.100	2.36	77	4	0.46	279	0.678
100	1,476.800	2.49	76	5	0.49	285	0.700
120	1,494.900	2.04	75	6	0.40	281	0.632
	1,511.316						

**Client:** ASARCO LLC - Hayden Operations      **Run:** 3-PT  
**Source:** Hayden Smelter - Acid Plant (S2)      **Date:** 12/20/16

### Field Data Input: (Continued)

<u>Traverse Data</u>		<u>Stack Dimensional Data:</u>	
Barometric Pressure, P <sub>b</sub>	27.99 "Hg	Circular	
Static Pressure	-0.69 "H <sub>2</sub> O	Diameter	8.167 ft
Pitot Factor, cp	0.84	Rectangular	
Meter Cal Factor	0.9976 Y	Width	0.000 ft
		Length	0.000 ft
		Stack Area	52.386 sq.ft.
<u>Moisture Data</u>			
Total Test Time	240 min		
Sample Time Interval	20 min	<u>EPA Method 3A</u>	
Meter Volume, V <sub>m</sub>	215.671 dcf	CO <sub>2</sub> Average	0.29 %vd
Water Volume	0.0 ml (g)	O <sub>2</sub> Average	15.53 %vd
Nozzle Diameter, N <sub>z</sub>	0.2820 sq.in.	<u>EPA Method 5</u>	
Nozzle Area	0.000434 sq.ft.	Wt. PT Collected	0.0080 grams

### Field Data Averages

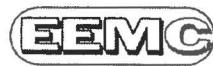
<u>Meter</u>	<u>Stack</u>
ΔH	2.460 "H <sub>2</sub> O /Dp
Temperature, T <sub>m</sub>	75.6 °F Temperature, T <sub>s</sub>
Temperature, T <sub>m</sub>	535.6 °A (°R) Temperature, T <sub>s</sub>
Pressure Meter, P <sub>m</sub>	28.171 "Hg Pressure Stack, P <sub>s</sub>

### Field Data Calculations

<u>EPA Method 4 Meter Box Capture</u>		<u>EPA Method 2 Stack Gas Flowrate:</u>	
Standard Volume, V <sub>m(std)</sub>	199.735 dscf	Velocity, V <sub>s</sub>	48.22 fps
Actual Volume, V <sub>m(actual)</sub>	302.039 awcf	Volume (actual)	151,563.2 awcfm
<u>EPA Method 4 Gas Stream Moisture</u>		Volume (standard)	6,012,623.3 wscf/hr
Moisture Vapor, V <sub>w(std)</sub>	0.000 scf		6,012,623.3 dscf/hr
Moisture, B <sub>ws</sub>	0.0000		
Percent Moisture	0.00 %v	<u>EPA Method 5 Particulate Emissions:</u>	
		Concentration, C <sub>s</sub>	0.0006 gr/dscf
		Concentration, gr/awcf	0.0004 gr/awcf
<u>EPA Method 3 Gas Density</u>		Percent Isokinetic	0.52 lb/hr
Dry, M <sub>d</sub>	28.67 lb/lb-mole	Mass Emissions	
Wet, M <sub>s</sub>	28.67 lb/lb-mole		
			100.3 %



## MOISTURE DETERMINATION



Company Name:	NADA JD	Run:	3
Plant Location:	Hayden, AZ	Test Date:	12/26/16
Source Tested:	ACID PLANT (att10)	Start Time:	1414
Weighed By:	GW	Balance Level:	✓
		Balance Zeroed:	✓
		End Time:	1825
		Liquid Appearance:	Impinger caddy color
		(clear, cloudy, dark etc.)	Grey

WEIGHT (Grams)

## Impinger 1:

Final Weight: 659.8      Filter ID: 15  
 Initial Weight: 701.1      Probe Length: 10'  
 Weight Gain: -41.3      Probe Material: GLASS  
~~1090 H<sub>2</sub>O<sub>2</sub>~~

## Impinger 2:

Final Weight: 708.6      Filter ID: 15  
 Initial Weight: 720.3      Probe Length: 10'  
 Weight Gain: -11.7      Probe Material: GLASS  
~~1090 H<sub>2</sub>O<sub>2</sub>~~

## Impinger 3:

Final Weight: 698.8      Filter ID: 15  
 Initial Weight: 699.7      Probe Length: 10'  
 Weight Gain: -0.9      Probe Material: GLASS  
~~1090 H<sub>2</sub>O<sub>2</sub>~~

## Impinger 4: (if applicable)

Final Weight: 572.9      Filter ID: 15  
 Initial Weight: 565.9      Probe Length: 10'  
 Weight Gain: +7.0      Probe Material: GLASS  
~~empty~~

## Impinger 5: (if applicable)

Final Weight:      Filter ID: 15  
 Initial Weight:      Probe Length: 10'  
 Weight Gain:      Probe Material: GLASS

## Silica Gel Impinger:

Final Weight: 1004.9      Silica Gel Spent (please circle)  
 Initial Weight: 961.9      Yes / No  
 Weight Gain: +43.0

Total Mass of Water Captured: -3.9 grams (ml)

Notes

# Particulate Laboratory Data

COMPANY NAME: ASARCO  
 LOCATION: HAYDEN, AZ  
 SOURCE: ACID PT. DUCT

RUN: 3-pt-  
 DATE: 12/12/16  
 METHOD: SP

Filter 15 M

## Tare Weights

Filter	Weight	Date	Time
Filter	<u>15 M</u>		
1	<u>2964</u>	<u>12/14/16</u>	<u>0900</u>
2	<u>2963</u>	<u>15</u>	<u>0800</u>
3	<u>2963</u>	<u>16</u>	<u>0800</u>
Average	<u>2963</u>	—	—

Filter Appearance: light gray

Probe 3B

## Tare Weights in Wash

Wash	Weight	Date	Time
Wash			
1	<u>87.468</u>	<u>12/14/16</u>	<u>0900</u>
2	<u>87.467</u>	<u>15</u>	<u>0800</u>
3	<u>87.467</u>	<u>16</u>	<u>0800</u>
Average	<u>87.468</u>	—	—

Wash Appearance: light black specks  
 Acetone Wash Volume: 125 ml

## Sample Weights

Probe Wash	Weight	Date	Time
Beaker/Dish/Run:			
Description:			
1	<u>87.414</u>	<u>12/12/16</u>	<u>0900</u>
2	<u>87.411</u>	<u>23</u>	<u>0900</u>
3	<u>87.410</u>	<u>23</u>	<u>0900</u>
Final Weight Average:	<u>87.411</u>	—	—
Tare Weight:	<u>87.463</u>	—	—
Net Weight:	<u>.0044</u>	—	—

Filter Catch	Weight	Date	Time
1	<u>2962</u>	<u>12/12/16</u>	<u>0900</u>
2	<u>2798</u>	<u>23</u>	<u>0900</u>
3	<u>2798</u>	<u>24</u>	<u>0900</u>
Final Weight Average:	<u>2799</u>	—	—
Tare Weight:	<u>2763</u>	—	—
Net Weight:	<u>.0036</u>	—	—

$$\% \text{ Delta} = ((\text{Net Wt} - \text{Audit Value}) / \text{audit value}) * 100$$

% Delta = See R

Probe and Cyclone Residue .0044 g - .0000 g (blank) = .0044 g ✓

Impinger Residue — g - — g (blank) = — g

EPA Method (Filter, Probe & Cyclone Residue) = .0080 g ✓

Particulate Weight (including impingers) = — g

Notes: \_\_\_\_\_

## Particulate Laboratory Data

COMPANY NAME: ASARCO  
 LOCATION: HAYDEN AP  
 SOURCE: Acid pt Duct

RUN: b (air) - LNASH  
 DATE: TST 12/12/2011  
 METHOD: CB

### Filter

b) air/l

#### Tare Weights

	Weight	Date	Time
Filter			
1			
2			
3			
Average			

Filter Appearance: \_\_\_\_\_

### Probe

#### Tare Weights in Wash

	Weight	Date	Time
Wash			
1	91.2747	12/14/11	0900
2	91.2745	15	0900
3	91.2746	16	0900
Average	91.2745	—	—
	91.2746		

Wash Appearance: \_\_\_\_\_

Acetone Wash Volume: 175 ml

blank

### Sample Weights

Probe Wash			
Beaker/Dish/Run:			
Description:			
	Weight	Date	Time
1	91.2745	12/13/11	0900
2	91.2741	24	0900
3	91.2742	27	0900
Final Weight Average:	91.2743	—	—
Tare Weight:	91.2746	—	—
Net Weight:	.0030	—	—

Filter Catch			
	Weight	Date	Time
1			
2			
3			
Final Weight Average:			
Tare Weight:			
Net Weight:			

$$\% \text{ Delta} = ((\text{Net Wt} - \text{Audit Value}) / \text{audit value}) * 100$$

% Delta = See Run #1

Probe and Cyclone Residue g - .0000 g (bl) = g

Impinger Residue g - .0000 g (blank) = g

EPA Method (Filter, Probe & Cyclone Residue) = g

Particulate Weight (including impingers) = g

Notes: \_\_\_\_\_

**REFERENCE DATA****EPA METHOD 3A**

**Client:** ASARCO LLC - Hayden Operations  
**Location:** Hayden, Arizona  
**Source:** Hayden Smelter - Acid Plant (S2)

**Run:** 1-O2CO2  
**Time:** 12:48-17:05  
**Date:** 12/19/16

Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd	Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd
1	12:48	0.20	13.72	36	13:23	0.30	16.91
2	12:49	0.20	13.69	37	13:24	0.30	16.90
3	12:50	0.20	13.51	38	13:25	0.30	16.90
4	12:51	0.27	13.18	39	13:26	0.30	16.90
5	12:52	0.30	12.86	40	13:27	0.29	16.90
6	12:53	0.30	12.78	41	13:28	0.20	16.98
7	12:54	0.30	12.71	42	13:29	0.20	16.41
8	12:55	0.30	12.70	43	13:30	0.20	14.42
9	12:56	0.30	12.87	44	13:31	0.20	13.96
10	12:57	0.30	15.09	45	13:32	0.20	13.85
11	12:58	0.30	16.10	46	13:33	0.20	13.69
12	12:59	0.30	13.99	47	13:34	0.23	13.53
13	13:00	0.30	12.95	48	13:35	0.30	13.42
14	13:01	0.30	13.06	49	13:36	0.25	13.40
15	13:02	0.30	13.64	50	13:37	0.30	13.40
16	13:03	0.30	15.76	51	13:38	0.30	13.38
17	13:04	0.30	15.33	52	13:39	0.35	13.24
18	13:05	0.30	14.04	53	13:40	0.40	13.10
19	13:06	0.30	14.09	54	13:41	0.40	12.94
20	13:07	0.30	14.17	55	13:42	0.40	12.89
21	13:08	0.30	14.36	56	13:43	0.40	12.80
22	13:09	0.30	15.83	57	13:44	0.40	12.77
23	13:10	0.30	14.90	58	13:45	0.40	12.71
24	13:11	0.25	16.10	59	13:46	0.40	12.70
25	13:12	0.20	16.78	60	13:47	0.34	12.67
26	13:13	0.27	16.54	61	13:48	0.30	12.62
27	13:14	0.30	16.74	62	13:49	0.30	12.70
28	13:15	0.30	16.90	63	13:50	0.30	12.70
29	13:16	0.30	16.90	64	13:51	0.29	12.74
30	13:17	0.30	16.93	65	13:52	0.20	13.00
31	13:18	0.30	16.99	66	13:53	0.20	13.32
32	13:19	0.27	17.00	67	13:54	0.20	13.87
33	13:20	0.30	17.00	68	13:55	0.20	12.54
34	13:21	0.30	16.98	69	13:56	0.20	13.53
35	13:22	0.30	16.93	70	13:57	0.20	14.28

<b>Client:</b>	<b>ASARCO LLC - Hayden Operations</b>				<b>Run:</b>	<b>1-O2CO2</b>	
<b>Source:</b>	<b>Hayden Smelter - Acid Plant (S2)</b>				<b>Date:</b>	<b>12/19/2016</b>	
Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd	Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd
71	13:58	0.20	13.28	112	14:39	0.30	14.23
72	13:59	0.20	11.48	113	14:40	0.30	13.94
73	14:00	0.20	11.10	114	14:41	0.30	13.56
74	14:01	0.20	11.08	115	14:42	0.30	13.58
75	14:02	0.20	10.77	116	14:43	0.30	13.07
76	14:03	0.20	10.60	117	14:44	0.30	12.96
77	14:04	0.20	10.59	118	14:45	0.30	12.41
78	14:05	0.20	12.29	119	14:46	0.30	12.28
79	14:06	0.20	13.03	120	14:47	0.30	12.32
80	14:07	0.20	13.78	121	14:48	0.30	12.71
81	14:08	0.29	14.05	122	14:49	0.30	13.40
82	14:09	0.30	13.80	123	14:50	0.30	14.73
83	14:10	0.30	13.05	124	14:51	0.30	15.10
84	14:11	0.30	12.10	125	14:52	0.30	15.10
85	14:12	0.30	12.11	126	14:53	0.30	15.02
86	14:13	0.30	12.30	127	14:54	0.30	14.80
87	14:14	0.30	12.40	128	14:55	0.30	14.49
88	14:15	0.30	12.33	129	14:56	0.30	15.45
89	14:16	0.30	12.13	130	14:57	0.30	15.32
90	14:17	0.30	11.48	131	14:58	0.30	14.64
91	14:18	0.30	10.97	132	14:59	0.30	14.17
92	14:19	0.30	11.23	133	15:00	0.30	14.03
93	14:20	0.30	11.35	134	15:01	0.30	13.89
94	14:21	0.30	10.98	135	15:02	0.30	13.94
95	14:22	0.30	11.95	136	15:03	0.30	14.02
96	14:23	0.30	12.70	137	15:04	0.30	14.15
97	14:24	0.30	12.89	138	15:05	0.30	14.20
98	14:25	0.30	12.90	139	15:06	0.30	14.46
99	14:26	0.30	12.89	140	15:07	0.30	14.68
100	14:27	0.30	12.66	141	15:08	0.30	14.78
101	14:28	0.30	12.99	142	15:09	0.30	13.23
102	14:29	0.30	11.56	143	15:10	0.30	12.52
103	14:30	0.30	10.75	144	15:11	0.30	11.87
104	14:31	0.30	10.38	145	15:12	0.30	11.05
105	14:32	0.38	10.06	146	15:13	0.30	10.60
106	14:33	0.36	10.55	147	15:14	0.30	11.16
107	14:34	0.30	10.64	148	15:15	0.30	11.53
108	14:35	0.30	10.58	149	15:16	0.30	11.76
109	14:36	0.30	11.62	150	15:17	0.30	12.09
110	14:37	0.30	12.65	151	15:18	0.30	12.41
111	14:38	0.30	13.61	152	15:19	0.30	12.61

<b>Client:</b>	<b>ASARCO LLC - Hayden Operations</b>				<b>Run:</b>	<b>1-O2CO2</b>	
<b>Source:</b>	<b>Hayden Smelter - Acid Plant (S2)</b>				<b>Date:</b>	<b>12/19/2016</b>	
Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd	Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd
153	15:20	0.30	12.61	193	16:00	0.30	14.14
154	15:21	0.30	12.88	194	16:01	0.30	13.84
155	15:22	0.30	13.13	195	16:02	0.30	13.98
156	15:23	0.30	13.61	196	16:03	0.30	14.31
157	15:24	0.30	13.79	197	16:04	0.30	13.09
158	15:25	0.30	13.76	198	16:05	0.30	11.41
159	15:26	0.30	13.29	199	16:06	0.30	11.08
160	15:27	0.30	13.08	200	16:07	0.30	10.87
161	15:28	0.30	13.57	201	16:08	0.30	10.62
162	15:29	0.30	16.04	202	16:09	0.30	10.37
163	15:30	0.30	16.74	203	16:10	0.30	10.51
164	15:31	0.30	16.78	204	16:11	0.30	11.09
165	15:32	0.30	15.66	205	16:12	0.30	11.46
166	15:33	0.30	14.38	206	16:13	0.30	11.71
167	15:34	0.30	13.80	207	16:14	0.30	11.90
168	15:35	0.30	13.55	208	16:15	0.30	11.98
169	15:36	0.30	13.85	209	16:16	0.30	12.26
170	15:37	0.30	13.87	210	16:17	0.30	12.74
171	15:38	0.30	13.93	211	16:18	0.30	12.83
172	15:39	0.30	16.25	212	16:19	0.30	12.56
173	15:40	0.30	15.90	213	16:20	0.30	12.41
174	15:41	0.30	14.32	214	16:21	0.30	12.23
175	15:42	0.30	14.20	215	16:22	0.31	12.45
176	15:43	0.30	14.13	216	16:23	0.30	13.26
177	15:44	0.30	14.02	217	16:24	0.30	13.53
178	15:45	0.30	13.90	218	16:25	0.30	13.57
179	15:46	0.30	13.90	219	16:26	0.30	14.30
180	15:47	0.30	13.83	220	16:27	0.30	14.44
181	15:48	0.30	13.80	221	16:28	0.30	13.91
182	15:49	0.30	13.80	222	16:29	0.30	12.81
183	15:50	0.30	13.80	223	16:30	0.30	12.19
184	15:51	0.30	13.80	224	16:31	0.30	12.09
185	15:52	0.38	13.80	225	16:32	0.30	12.29
186	15:53	0.35	13.73	226	16:33	0.30	12.62
187	15:54	0.30	13.77	227	16:34	0.30	12.89
188	15:55	0.37	13.74	228	16:35	0.30	13.16
189	15:56	0.34	13.70	229	16:36	0.30	13.06
190	15:57	0.30	13.70	230	16:37	0.30	14.23
191	15:58	0.30	13.70	231	16:38	0.30	13.22
192	15:59	0.30	13.94	232	16:39	0.30	13.06

**Client:** ASARCO LLC - Hayden Operations  
**Source:** Hayden Smelter - Acid Plant (S2)

**Run:** 1-O2CO2  
**Date:** 12/19/2016

Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd	Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd
233	16:40	0.30	13.60	246	16:53	0.30	14.66
234	16:41	0.30	13.85	247	16:54	0.30	14.98
235	16:42	0.30	13.97	248	16:55	0.30	13.66
236	16:43	0.30	13.44	249	16:56	0.30	13.99
237	16:44	0.20	14.31	250	16:57	0.30	14.67
238	16:45	0.20	15.20	251	16:58	0.30	14.30
239	16:46	0.30	13.48	252	16:59	0.30	14.13
240	16:47	0.30	12.51	253	17:00	0.30	14.20
241	16:48	0.30	13.67	254	17:01	0.30	15.06
242	16:49	0.30	14.49	255	17:02	0.30	15.22
243	16:50	0.30	13.66	256	17:03	0.30	15.11
244	16:51	0.30	14.01	257	17:04	0.30	16.31
245	16:52	0.30	14.13	258	17:05	0.30	16.50

<b>Averages:</b>	CO <sub>2</sub>	O <sub>2</sub>
	%vd	%vd
	<b>0.293</b>	<b>13.546</b>

**Client:** ASARCO LLC - Hayden Operations  
**Source:** Hayden Smelter - Acid Plant (S2)

**Run:** 1-O2CO2  
**Date:** 12/19/2016

### Instrument Calibration Checks

ACE (<2% span or 0.5 ppmvd)	SB <sub>i</sub> /SB <sub>f</sub> (<5% span or 0.5 ppmvd)	D (<3% span or 0.5 ppmvd)
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#### O<sub>2</sub> Instrument

ACE	Time	Value, C <sub>v</sub>	Resp, C <sub>Dir</sub>	ACE	CS:	20.99 %vd
(Calibration	11:28	0.0	0.00	0.0		
Error Tests)	12:10	11.03	11.00	-0.1		
	12:08	20.99	20.99	0.0		
SB <sub>i</sub>	Time	Resp, C <sub>Dir</sub>	Resp, C <sub>s</sub>	SB <sub>i</sub>		
(Initial System	12:38	0.00	0.28	1.3		
Bias Check)	12:43	11.00	10.80	-1.0		
SB <sub>p</sub>	Time	Resp, C <sub>Dir</sub>	Resp, C <sub>s</sub>	SB <sub>f</sub>	D  SB <sub>f</sub> - Sbi  Drift	
(Post System	17:09	0.00	0.53	2.5		1.2
Bias Check)	17:14	11.00	10.80	-1.0		0.0

#### CO<sub>2</sub> Instrument

ACE	Time	Value, C <sub>v</sub>	Resp, C <sub>Dir</sub>	ACE	CS:	19.49 %vd
(Calibration	11:28	0.0	0.00	0.0		
Error Tests)	12:10	10.99	11.00	0.1		
	12:08	19.49	19.47	-0.1		
SB <sub>i</sub>	Time	Resp, C <sub>Dir</sub>	Resp, C <sub>s</sub>	SB <sub>i</sub>		
(Initial System	12:38	0.00	0.00	0.0		
Bias Check)	12:43	11.00	10.98	-0.1		
SB <sub>p</sub>	Time	Resp, C <sub>Dir</sub>	Resp, C <sub>s</sub>	SB <sub>f</sub>	D  SB <sub>f</sub> - Sbi  Drift	
(Post System	17:09	0.00	0.03	0.2		0.2
Bias Check)	17:14	11.00	11.16	0.8		0.9

#### Instrument Response Times:

#### Averages:

O <sub>2</sub>	Zero	High	O <sub>2</sub>	13.546 %vd
CO <sub>2</sub>	61	61 seconds	CO <sub>2</sub>	0.293 %vd
O <sub>2</sub>	60	60 seconds	<b>Calibration Corrected Values:</b>	
CO <sub>2</sub>			O <sub>2</sub>	13.94 %vd
			CO <sub>2</sub>	0.28 %vd

**REFERENCE DATA****EPA METHOD 3A**

**Client:** ASARCO LLC - Hayden Operations  
**Location:** Hayden, Arizona  
**Source:** Hayden Smelter - Acid Plant (S2)

**Run:** 2-O2CO2  
**Time:** 08:48-13:29  
**Date:** 12/20/16

Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd	Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd
1	08:48	0.40	17.48	36	09:23	0.40	11.92
2	08:49	0.40	17.50	37	09:24	0.40	11.89
3	08:50	0.40	17.40	38	09:25	0.40	11.85
4	08:51	0.40	17.43	39	09:26	0.40	11.79
5	08:52	0.40	17.50	40	09:27	0.40	11.75
6	08:53	0.30	17.54	41	09:28	0.40	11.62
7	08:54	0.30	17.55	42	09:29	0.40	11.76
8	08:55	0.30	15.82	43	09:30	0.40	11.93
9	08:56	0.30	15.33	44	09:31	0.36	12.36
10	08:57	0.30	14.32	45	09:32	0.30	13.11
11	08:58	0.30	13.28	46	09:33	0.30	14.49
12	08:59	0.37	13.85	47	09:34	0.30	13.41
13	09:00	0.40	14.29	48	09:35	0.30	13.18
14	09:01	0.39	14.45	49	09:36	0.30	13.75
15	09:02	0.40	14.51	50	09:37	0.30	13.97
16	09:03	0.40	14.47	51	09:38	0.30	14.20
17	09:04	0.40	14.34	52	09:39	0.30	13.76
18	09:05	0.40	14.92	53	09:40	0.30	13.29
19	09:06	0.40	16.61	54	09:41	0.30	12.90
20	09:07	0.33	17.08	55	09:42	0.30	13.31
21	09:08	0.30	16.48	56	09:43	0.29	13.79
22	09:09	0.30	16.01	57	09:44	0.20	15.44
23	09:10	0.30	15.95	58	09:45	0.20	16.91
24	09:11	0.30	15.66	59	09:46	0.21	17.41
25	09:12	0.33	15.15	60	09:47	0.30	16.23
26	09:13	0.39	14.77	61	09:48	0.30	16.10
27	09:14	0.30	14.83	62	09:49	0.30	16.15
28	09:15	0.30	14.81	63	09:50	0.30	16.20
29	09:16	0.30	14.62	64	09:51	0.30	16.20
30	09:17	0.39	13.06	65	09:52	0.30	16.09
31	09:18	0.40	12.36	66	09:53	0.30	15.57
32	09:19	0.31	12.11	67	09:54	0.30	15.33
33	09:20	0.32	12.19	68	09:55	0.30	15.09
34	09:21	0.40	12.13	69	09:56	0.30	15.22
35	09:22	0.40	12.10	70	09:57	0.30	15.47

<b>Client:</b>	<b>ASARCO LLC - Hayden Operations</b>				<b>Run:</b>	<b>2-O2CO2</b>	
<b>Source:</b>	<b>Hayden Smelter - Acid Plant (S2)</b>				<b>Date:</b>	<b>12/20/2016</b>	
Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd	Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd
71	09:58	0.30	15.71	112	10:39	0.24	13.93
72	09:59	0.30	15.83	113	10:40	0.29	14.59
73	10:00	0.30	15.97	114	10:41	0.16	15.46
74	10:01	0.30	16.08	115	10:42	0.10	15.24
75	10:02	0.30	15.54	116	10:43	0.21	14.18
76	10:03	0.30	14.96	117	10:44	0.36	14.01
77	10:04	0.30	14.69	118	10:45	0.30	14.10
78	10:05	0.30	14.96	119	10:46	0.30	14.05
79	10:06	0.30	14.86	120	10:47	0.30	13.90
80	10:07	0.30	14.71	121	10:48	0.30	13.99
81	10:08	0.30	14.61	122	10:49	0.30	14.00
82	10:09	0.30	14.80	123	10:50	0.30	13.92
83	10:10	0.30	14.95	124	10:51	0.31	13.83
84	10:11	0.30	15.01	125	10:52	0.38	13.79
85	10:12	0.30	15.16	126	10:53	0.30	13.82
86	10:13	0.30	15.30	127	10:54	0.30	14.00
87	10:14	0.30	15.72	128	10:55	0.30	14.17
88	10:15	0.30	17.03	129	10:56	0.27	14.28
89	10:16	0.30	17.32	130	10:57	0.20	14.18
90	10:17	0.30	16.84	131	10:58	0.25	13.73
91	10:18	0.30	15.33	132	10:59	0.30	13.50
92	10:19	0.30	13.65	133	11:00	0.30	13.59
93	10:20	0.30	12.53	134	11:01	0.30	14.50
94	10:21	0.30	12.23	135	11:02	0.30	16.49
95	10:22	0.30	12.58	136	11:03	0.30	16.36
96	10:23	0.30	13.70	137	11:04	0.30	15.41
97	10:24	0.30	14.21	138	11:05	0.30	13.60
98	10:25	0.30	14.55	139	11:06	0.30	12.27
99	10:26	0.30	14.89	140	11:07	0.30	12.00
100	10:27	0.30	15.10	141	11:08	0.30	11.84
101	10:28	0.30	15.32	142	11:09	0.30	11.74
102	10:29	0.30	15.48	143	11:10	0.30	11.78
103	10:30	0.30	16.18	144	11:11	0.30	11.60
104	10:31	0.30	17.19	145	11:12	0.40	11.75
105	10:32	0.30	17.30	146	11:13	0.40	11.61
106	10:33	0.30	16.12	147	11:14	0.40	12.11
107	10:34	0.30	15.33	148	11:15	0.30	13.77
108	10:35	0.30	14.45	149	11:16	0.30	14.56
109	10:36	0.30	14.08	150	11:17	0.30	15.76
110	10:37	0.30	13.95	151	11:18	0.30	16.09
111	10:38	0.27	13.92	152	11:19	0.30	15.35

<b>Client:</b>	<b>ASARCO LLC - Hayden Operations</b>				<b>Run:</b>	<b>2-O2CO2</b>	
<b>Source:</b>	<b>Hayden Smelter - Acid Plant (S2)</b>				<b>Date:</b>	<b>12/20/2016</b>	
Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd	Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd
153	11:20	0.30	15.35	193	12:00	0.20	13.98
154	11:21	0.30	15.30	194	12:01	0.20	13.96
155	11:22	0.30	15.30	195	12:02	0.20	13.68
156	11:23	0.30	15.30	196	12:03	0.20	13.42
157	11:24	0.30	15.38	197	12:04	0.20	13.57
158	11:25	0.30	15.45	198	12:05	0.20	13.47
159	11:26	0.30	15.52	199	12:06	0.20	13.41
160	11:27	0.30	15.51	200	12:07	0.20	13.49
161	11:28	0.30	15.20	201	12:08	0.20	13.63
162	11:29	0.30	15.20	202	12:09	0.20	14.82
163	11:30	0.30	15.20	203	12:10	0.20	15.55
164	11:31	0.30	15.44	204	12:11	0.20	16.91
165	11:32	0.30	15.61	205	12:12	0.20	15.87
166	11:33	0.30	15.67	206	12:13	0.20	15.42
167	11:34	0.30	14.66	207	12:14	0.20	15.44
168	11:35	0.30	14.33	208	12:15	0.26	15.08
169	11:36	0.30	14.18	209	12:16	0.30	15.00
170	11:37	0.30	13.86	210	12:17	0.30	14.95
171	11:38	0.30	13.85	211	12:18	0.27	15.03
172	11:39	0.30	13.64	212	12:19	0.20	15.52
173	11:40	0.30	13.75	213	12:20	0.20	16.15
174	11:41	0.30	14.16	214	12:21	0.20	15.35
175	11:42	0.30	13.91	215	12:22	0.20	14.11
176	11:43	0.30	13.69	216	12:23	0.22	13.49
177	11:44	0.30	13.70	217	12:24	0.30	12.89
178	11:45	0.30	13.30	218	12:25	0.30	12.79
179	11:46	0.30	13.29	219	12:26	0.30	12.76
180	11:47	0.30	13.28	220	12:27	0.30	12.85
181	11:48	0.30	13.15	221	12:28	0.30	14.18
182	11:49	0.30	14.43	222	12:29	0.30	14.88
183	11:50	0.30	14.89	223	12:30	0.30	15.04
184	11:51	0.30	13.79	224	12:31	0.30	16.22
185	11:52	0.30	13.49	225	12:32	0.30	15.63
186	11:53	0.30	14.79	226	12:33	0.30	14.59
187	11:54	0.30	15.24	227	12:34	0.30	14.40
188	11:55	0.30	15.93	228	12:35	0.30	14.39
189	11:56	0.30	15.72	229	12:36	0.30	14.73
190	11:57	0.30	14.32	230	12:37	0.30	14.83
191	11:58	0.30	13.76	231	12:38	0.24	13.99
192	11:59	0.29	13.81	232	12:39	0.30	12.74

**Client:** ASARCO LLC - Hayden Operations  
**Source:** Hayden Smelter - Acid Plant (S2)

**Run:** 2-O2CO2  
**Date:** 12/20/2016

Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd	Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd
233	12:40	0.30	12.76	259	13:06	0.30	17.39
234	12:41	0.30	12.67	260	13:07	0.30	17.57
235	12:42	0.30	12.24	261	13:08	0.30	17.61
236	12:43	0.30	12.34	262	13:09	0.30	17.74
237	12:44	0.30	13.72	263	13:10	0.30	17.71
238	12:45	0.30	14.14	264	13:11	0.30	17.60
239	12:46	0.30	13.87	265	13:12	0.30	17.53
240	12:47	0.30	13.53	266	13:13	0.30	17.48
241	12:48	0.30	13.50	267	13:14	0.30	17.36
242	12:49	0.30	13.82	268	13:15	0.30	17.38
243	12:50	0.30	14.05	269	13:16	0.30	17.30
244	12:51	0.30	13.64	270	13:17	0.30	17.35
245	12:52	0.30	13.24	271	13:18	0.30	16.47
246	12:53	0.30	13.10	272	13:19	0.30	14.97
247	12:54	0.30	13.09	273	13:20	0.30	14.98
248	12:55	0.30	13.31	274	13:21	0.30	14.92
249	12:56	0.30	14.59	275	13:22	0.24	14.59
250	12:57	0.30	14.99	276	13:23	0.30	14.39
251	12:58	0.30	15.00	277	13:24	0.30	14.52
252	12:59	0.30	15.01	278	13:25	0.30	14.65
253	13:00	0.30	15.24	279	13:26	0.30	14.70
254	13:01	0.30	15.17	280	13:27	0.30	14.71
255	13:02	0.30	15.06	281	13:28	0.30	14.21
256	13:03	0.30	14.86	282	13:29	0.30	13.57
257	13:04	0.30	15.19				
258	13:05	0.30	16.98				

<b>Averages:</b>	CO <sub>2</sub> %vd	O <sub>2</sub> %vd
	<b>0.300</b>	<b>14.612</b>

**Client:** ASARCO LLC - Hayden Operations  
**Source:** Hayden Smelter - Acid Plant (S2)

**Run:** 2-O2CO2  
**Date:** 12/20/2016

### Instrument Calibration Checks

ACE (<2% span or 0.5 ppmvd)	SB <sub>i</sub> /SB <sub>f</sub> (<5% span or 0.5 ppmvd)	D (<3% span or 0.5 ppmvd)
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#### O<sub>2</sub> Instrument

ACE	Time	Value, C <sub>v</sub>	Resp, C <sub>Dir</sub>	ACE	CS:	20.99 %vd
(Calibration	7:52	0.0	-0.06	-0.3		
Error Tests)	8:02	11.03	11.00	-0.1		
	7:59	20.99	21.03	0.2		
SB <sub>i</sub>	Time	Resp, C <sub>Dir</sub>	Resp, C <sub>s</sub>	SB <sub>i</sub>		
(Initial System	8:10	-0.06	0.14	1.0		
Bias Check)	8:16	11.00	11.11	0.5		
SB <sub>p</sub>	Time	Resp, C <sub>Dir</sub>	Resp, C <sub>s</sub>	SB <sub>f</sub>	D  SB <sub>f</sub> - Sbi  Drift	
(Post System	13:37	-0.06	0.15	1.0		0.0
Bias Check)	13:40	11.00	10.61	-1.9		2.4

#### CO<sub>2</sub> Instrument

ACE	Time	Value, C <sub>v</sub>	Resp, C <sub>Dir</sub>	ACE	CS:	19.49 %vd
(Calibration	7:52	0.0	0.00	0.0		
Error Tests)	8:02	10.99	10.90	-0.5		
	7:59	19.49	19.43	-0.3		
SB <sub>i</sub>	Time	Resp, C <sub>Dir</sub>	Resp, C <sub>s</sub>	SB <sub>i</sub>		
(Initial System	8:10	0.00	0.00	0.0		
Bias Check)	8:16	10.90	10.91	0.1		
SB <sub>p</sub>	Time	Resp, C <sub>Dir</sub>	Resp, C <sub>s</sub>	SB <sub>f</sub>	D  SB <sub>f</sub> - Sbi  Drift	
(Post System	13:37	0.00	0.00	0.0		0.0
Bias Check)	13:40	10.90	10.87	-0.2		0.3

#### Instrument Response Times:

#### Averages:

O <sub>2</sub>	Zero	High	O <sub>2</sub>	14.612 %vd
CO <sub>2</sub>	61	61 seconds	CO <sub>2</sub>	0.300 %vd
O <sub>2</sub>	60	60 seconds	<b>Calibration Corrected Values:</b>	
CO <sub>2</sub>			O <sub>2</sub>	14.89 %vd
			CO <sub>2</sub>	0.30 %vd

**REFERENCE DATA****EPA METHOD 3A**

**Client:** ASARCO LLC - Hayden Operations  
**Location:** Hayden, Arizona  
**Source:** Hayden Smelter - Acid Plant (S2)

**Run:** 3-O2CO2  
**Time:** 14:14-18:25  
**Date:** 12/20/16

Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd	Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd
1	14:14	0.30	13.27	36	14:49	0.30	14.62
2	14:15	0.30	13.82	37	14:50	0.30	13.82
3	14:16	0.30	13.89	38	14:51	0.30	15.72
4	14:17	0.30	14.00	39	14:52	0.30	17.16
5	14:18	0.30	13.70	40	14:53	0.30	17.33
6	14:19	0.30	13.58	41	14:54	0.30	17.48
7	14:20	0.30	13.51	42	14:55	0.30	17.52
8	14:21	0.30	13.50	43	14:56	0.30	17.44
9	14:22	0.30	13.50	44	14:57	0.30	17.47
10	14:23	0.30	13.50	45	14:58	0.30	17.73
11	14:24	0.30	13.49	46	14:59	0.30	17.65
12	14:25	0.30	13.48	47	15:00	0.30	17.57
13	14:26	0.30	13.42	48	15:01	0.30	16.78
14	14:27	0.30	13.41	49	15:02	0.30	16.38
15	14:28	0.31	13.03	50	15:03	0.30	16.34
16	14:29	0.30	12.92	51	15:04	0.30	16.33
17	14:30	0.30	13.59	52	15:05	0.30	14.80
18	14:31	0.30	14.54	53	15:06	0.30	13.19
19	14:32	0.30	14.60	54	15:07	0.30	12.49
20	14:33	0.30	14.60	55	15:08	0.30	11.66
21	14:34	0.30	14.61	56	15:09	0.30	11.25
22	14:35	0.30	14.63	57	15:10	0.26	13.53
23	14:36	0.30	14.63	58	15:11	0.20	14.68
24	14:37	0.30	14.63	59	15:12	0.20	14.72
25	14:38	0.30	14.62	60	15:13	0.20	14.69
26	14:39	0.30	14.70	61	15:14	0.22	14.82
27	14:40	0.30	14.70	62	15:15	0.30	13.19
28	14:41	0.30	14.70	63	15:16	0.30	11.88
29	14:42	0.30	14.74	64	15:17	0.30	11.88
30	14:43	0.30	14.75	65	15:18	0.30	11.95
31	14:44	0.30	14.67	66	15:19	0.30	12.06
32	14:45	0.30	14.90	67	15:20	0.30	12.36
33	14:46	0.30	14.85	68	15:21	0.30	12.51
34	14:47	0.30	14.93	69	15:22	0.30	12.56
35	14:48	0.30	15.35	70	15:23	0.30	12.74

**Client:** ASARCO LLC - Hayden Operations  
**Source:** Hayden Smelter - Acid Plant (S2)

**Run:** 3-O2CO2  
**Date:** 12/20/2016

Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd	Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd
71	15:24	0.30	12.94	112	16:05	0.30	11.28
72	15:25	0.30	12.93	113	16:06	0.30	12.61
73	15:26	0.30	13.23	114	16:07	0.30	13.00
74	15:27	0.30	13.39	115	16:08	0.30	13.18
75	15:28	0.30	13.25	116	16:09	0.30	13.17
76	15:29	0.30	13.57	117	16:10	0.30	13.13
77	15:30	0.30	13.90	118	16:11	0.30	13.24
78	15:31	0.30	14.07	119	16:12	0.30	13.31
79	15:32	0.30	13.63	120	16:13	0.30	14.08
80	15:33	0.30	13.24	121	16:14	0.30	15.54
81	15:34	0.30	13.44	122	16:15	0.30	15.61
82	15:35	0.30	15.31	123	16:16	0.30	15.94
83	15:36	0.30	15.81	124	16:17	0.30	17.16
84	15:37	0.30	15.86	125	16:18	0.30	17.40
85	15:38	0.30	17.03	126	16:19	0.30	17.39
86	15:39	0.30	17.40	127	16:20	0.30	17.50
87	15:40	0.30	17.43	128	16:21	0.30	17.41
88	15:41	0.30	17.44	129	16:22	0.30	15.92
89	15:42	0.30	16.73	130	16:23	0.30	13.93
90	15:43	0.30	15.22	131	16:24	0.30	13.06
91	15:44	0.30	14.99	132	16:25	0.30	13.07
92	15:45	0.30	14.84	133	16:26	0.30	15.91
93	15:46	0.30	14.97	134	16:27	0.30	16.59
94	15:47	0.24	15.23	135	16:28	0.30	17.21
95	15:48	0.20	15.35	136	16:29	0.30	17.49
96	15:49	0.20	15.52	137	16:30	0.30	17.53
97	15:50	0.29	15.50	138	16:31	0.30	17.55
98	15:51	0.30	15.22	139	16:32	0.30	17.35
99	15:52	0.30	15.00	140	16:33	0.30	17.47
100	15:53	0.29	14.75	141	16:34	0.30	17.40
101	15:54	0.20	15.14	142	16:35	0.30	17.37
102	15:55	0.20	15.02	143	16:36	0.30	17.40
103	15:56	0.20	14.95	144	16:37	0.33	17.37
104	15:57	0.20	13.79	145	16:38	0.40	17.30
105	15:58	0.20	13.76	146	16:39	0.32	17.30
106	15:59	0.23	13.45	147	16:40	0.30	17.30
107	16:00	0.26	12.56	148	16:41	0.30	17.26
108	16:01	0.30	12.18	149	16:42	0.30	17.21
109	16:02	0.30	11.82	150	16:43	0.30	17.21
110	16:03	0.30	11.49	151	16:44	0.30	17.20
111	16:04	0.30	11.54	152	16:45	0.30	17.20

**Client:** ASARCO LLC - Hayden Operations  
**Source:** Hayden Smelter - Acid Plant (S2)

**Run:** 3-O2CO2  
**Date:** 12/20/2016

Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd	Minute	Time	CO <sub>2</sub> %vd	O <sub>2</sub> %vd
153	16:46	0.30	17.20	193	17:26	0.30	12.67
154	16:47	0.30	17.20	194	17:27	0.30	13.35
155	16:48	0.30	17.19	195	17:28	0.30	13.24
156	16:49	0.30	17.20	196	17:29	0.30	12.62
157	16:50	0.30	17.20	197	17:30	0.30	11.83
158	16:51	0.30	17.22	198	17:31	0.30	11.79
159	16:52	0.30	17.26	199	17:32	0.30	11.93
160	16:53	0.30	17.20	200	17:33	0.30	12.07
161	16:54	0.30	17.20	201	17:34	0.30	12.49
162	16:55	0.30	17.20	202	17:35	0.30	12.92
163	16:56	0.30	17.19	203	17:36	0.28	13.41
164	16:57	0.30	17.14	204	17:37	0.20	13.69
165	16:58	0.30	17.20	205	17:38	0.20	13.90
166	16:59	0.30	17.24	206	17:39	0.20	15.01
167	17:00	0.30	17.30	207	17:40	0.20	15.48
168	17:01	0.30	17.30	208	17:41	0.20	17.08
169	17:02	0.30	17.35	209	17:42	0.28	17.39
170	17:03	0.30	17.40	210	17:43	0.30	17.39
171	17:04	0.30	17.40	211	17:44	0.30	17.50
172	17:05	0.30	17.32	212	17:45	0.30	17.50
173	17:06	0.30	15.31	213	17:46	0.30	17.50
174	17:07	0.30	14.32	214	17:47	0.30	17.57
175	17:08	0.30	14.67	215	17:48	0.30	17.58
176	17:09	0.30	15.08	216	17:49	0.30	17.41
177	17:10	0.30	14.89	217	17:50	0.33	17.37
178	17:11	0.30	14.23	218	17:51	0.33	17.40
179	17:12	0.30	14.62	219	17:52	0.34	17.36
180	17:13	0.30	14.57	220	17:53	0.32	17.47
181	17:14	0.30	13.53	221	17:54	0.29	16.76
182	17:15	0.30	12.87	222	17:55	0.30	16.00
183	17:16	0.30	11.94	223	17:56	0.30	15.49
184	17:17	0.30	12.11	224	17:57	0.24	14.91
185	17:18	0.30	12.95	225	17:58	0.20	14.29
186	17:19	0.30	13.24	226	17:59	0.20	14.09
187	17:20	0.30	13.55	227	18:00	0.25	13.94
188	17:21	0.30	12.59	228	18:01	0.30	13.78
189	17:22	0.30	11.60	229	18:02	0.30	13.61
190	17:23	0.30	11.48	230	18:03	0.30	13.48
191	17:24	0.30	11.73	231	18:04	0.30	13.40
192	17:25	0.30	12.06	232	18:05	0.30	13.33

<b>Client:</b>	<b>ASARCO LLC - Hayden Operations</b>				<b>Run:</b>	<b>3-O2CO2</b>	
<b>Source:</b>	<b>Hayden Smelter - Acid Plant (S2)</b>				<b>Date:</b>	<b>12/20/2016</b>	
<b>Minute</b>	<b>Time</b>	<b>CO<sub>2</sub></b>	<b>O<sub>2</sub></b>	<b>Minute</b>	<b>Time</b>	<b>CO<sub>2</sub></b>	<b>O<sub>2</sub></b>
233	18:06	0.30	13.30				
234	18:07	0.30	13.22				
235	18:08	0.30	13.20				
236	18:09	0.30	13.20				
237	18:10	0.30	13.23				
238	18:11	0.30	13.25				
239	18:12	0.30	13.37				
240	18:13	0.30	13.20				
241	18:14	0.30	13.01				
242	18:15	0.30	13.32				
243	18:16	0.30	14.37				
244	18:17	0.30	14.60				
245	18:18	0.30	14.70				
246	18:19	0.30	14.90				
247	18:20	0.30	15.06				
248	18:21	0.30	15.14				
249	18:22	0.30	15.47				
250	18:23	0.30	15.67				
251	18:24	0.29	15.96				
252	18:25	0.20	16.23				

<b>Averages:</b>	<b>CO<sub>2</sub></b>	<b>O<sub>2</sub></b>
	<b>%vd</b>	<b>%vd</b>
	<b>0.292</b>	<b>14.866</b>

<b>Client:</b>	<b>ASARCO LLC - Hayden Operations</b>	<b>Run:</b>	<b>3-O2CO2</b>
<b>Source:</b>	<b>Hayden Smelter - Acid Plant (S2)</b>	<b>Date:</b>	<b>12/20/2016</b>

### Instrument Calibration Checks

ACE (<2% span or 0.5 ppmvd)	SB <sub>i</sub> /SB <sub>f</sub> (<5% span or 0.5 ppmvd)	D (<3% span or 0.5 ppmvd)
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#### O<sub>2</sub> Instrument

ACE	Time	Value, C <sub>v</sub>	Resp, C <sub>Dir</sub>	ACE	CS:	20.99 %vd
(Calibration	7:52	0.0	-0.06	-0.3		
Error Tests)	8:02	11.03	11.00	-0.1		
	7:59	20.99	21.03	0.2		
SB <sub>i</sub>	Time	Resp, C <sub>Dir</sub>	Resp, C <sub>s</sub>	SB <sub>i</sub>		
(Initial System	13:37	-0.06	0.15	1.0		
Bias Check)	13:40	11.00	10.61	-1.9		
SB <sub>p</sub>	Time	Resp, C <sub>Dir</sub>	Resp, C <sub>s</sub>	SB <sub>f</sub>	D  SB <sub>f</sub> - Sbi  Drift	
(Post System	18:31	-0.06	-0.43	-1.8		2.8
Bias Check)	18:34	11.00	10.43	-2.7		0.8

#### CO<sub>2</sub> Instrument

ACE	Time	Value, C <sub>v</sub>	Resp, C <sub>Dir</sub>	ACE	CS:	19.49 %vd
(Calibration	7:52	0.0	0.00	0.0		
Error Tests)	8:02	10.99	10.90	-0.5		
	7:59	19.49	19.43	-0.3		
SB <sub>i</sub>	Time	Resp, C <sub>Dir</sub>	Resp, C <sub>s</sub>	SB <sub>i</sub>		
(Initial System	13:37	0.00	0.00	0.0		
Bias Check)	13:40	10.90	10.87	-0.2		
SB <sub>p</sub>	Time	Resp, C <sub>Dir</sub>	Resp, C <sub>s</sub>	SB <sub>f</sub>	D  SB <sub>f</sub> - Sbi  Drift	
(Post System	18:31	0.00	0.00	0.0		0.0
Bias Check)	18:34	10.90	11.11	1.1		1.3

#### Instrument Response Times:

#### Averages:

O <sub>2</sub>	Zero	High	O <sub>2</sub>	14.866 %vd
CO <sub>2</sub>	61	61 seconds	CO <sub>2</sub>	0.292 %vd
O <sub>2</sub>	60	60 seconds	Calibration Corrected Values:	
CO <sub>2</sub>			O <sub>2</sub>	15.53 %vd

CO<sub>2</sub>      0.29 %vd

**ASARCO LLC - Hayden Operations**

**Hayden Smelter - Acid Plant (S2)**

**O<sub>2</sub>/CO<sub>2</sub> Computer Logger**

**Hayden, Arizona**

**12/19/16**

<b>Time</b>	<b>CO<sub>2</sub> %vd</b>	<b>O<sub>2</sub> %vd</b>	<b>Comments</b>
11:21	1.92	2.01	Instrument/Calibration Tank IDs/Run Times
11:22	0.00	-0.10	
11:23	0.00	No Data	<b>O<sub>2</sub>, Tank IDs:</b>
11:24	0.00	No Data	CC268790 @ 11.03%vd; Exp. 06/10/24
11:25	0.00	-0.20	SA15470 @ 20.99%vd; Exp. 05/12/23
11:26	0.00	-0.20	O <sub>2</sub> Instrument: Servomex 1400
11:27	0.00	0.07	
11:28	<u>0.00</u>	<u>0.00</u>	<b>CO, Tank IDs:</b>
11:29	0.00	-0.10	CC268790 @ 10.99%vd; Exp. 06/10/24
11:30	0.00	-0.10	SA15470 @ 19.49%vd; Exp. 05/12/23
11:31	0.00	15.69	CO <sub>2</sub> Instrument: Servomex 1440
11:32	0.00	21.73	
11:33	0.00	21.10	
11:34	-0.02	21.10	
11:35	0.00	21.10	
11:36	0.00	21.10	
11:37	0.00	21.10	
11:38	0.00	21.10	
11:39	0.00	21.11	
11:40	0.00	21.10	
11:41	0.00	21.10	
11:42	0.00	21.11	
11:43	0.00	21.10	
11:44	0.00	21.09	
11:45	0.00	21.10	
11:46	-0.02	21.10	
11:47	No Data	21.10	
11:48	No Data	21.11	
11:49	0.00	21.10	
11:50	0.00	21.10	
11:51	0.00	21.10	
11:52	0.00	21.10	
11:53	0.00	21.10	
11:54	0.00	21.10	
11:55	0.00	21.10	
11:56	0.00	21.09	
11:57	0.00	21.10	
11:58	0.00	21.10	
11:59	0.00	21.10	
12:00	0.00	21.10	
12:01	0.00	21.10	
12:02	0.00	21.10	

**ASARCO LLC - Hayden Operations****Hayden Smelter - Acid Plant (S2)****O<sub>2</sub>/CO<sub>2</sub> Computer Logger****Hayden, Arizona****12/19/16**

12:03	0.00	21.10
12:04	3.50	21.10
12:05	21.00	21.10
12:06	20.23	21.08
12:07	19.37	21.00
12:08	<u>19.47</u>	<u>20.99</u>
12:09	10.89	13.62
12:10	<u>11.00</u>	<u>11.00</u>
12:11	9.71	11.62
12:12	0.16	20.83
12:13	0.10	18.05
12:14	0.04	1.82
12:15	0.00	1.44
12:16	0.00	1.50
12:17	0.00	1.34
12:18	0.00	1.30
12:19	0.00	1.26
12:20	0.00	1.31
12:21	0.00	1.17      Begin Run 2
12:22	0.00	1.32
12:23	0.00	1.10
12:24	0.00	1.05
12:25	0.08	7.07
12:26	0.25	14.40
12:27	0.20	14.96
12:28	0.20	15.14
12:29	0.20	14.33
12:30	0.20	13.18
12:31	0.20	12.71
12:32	0.20	12.63
12:33	0.16	17.17
12:34	0.11	19.79
12:35	0.20	13.08
12:36	0.02	2.94
12:37	0.00	0.64
12:38	<u>0.00</u>	<u>0.28</u>
12:39	0.00	0.22
12:40	4.23	4.66
12:41	10.61	10.77
12:42	10.95	10.78
12:43	<u>10.98</u>	<u>10.80</u>
12:44	6.31	12.09
12:45	0.33	13.72
12:46	0.22	13.83

**ASARCO LLC - Hayden Operations****Hayden Smelter - Acid Plant (S2)****O<sub>2</sub>/CO<sub>2</sub> Computer Logger****Hayden, Arizona****12/19/16**

12:47	0.20	13.79
12:48	0.20	13.72
		Begin Run 1
12:49	0.20	13.69
12:50	0.20	13.51
12:51	0.27	13.18
12:52	0.30	12.86
12:53	0.30	12.78
12:54	0.30	12.71
12:55	0.30	12.70
12:56	0.30	12.87
12:57	0.30	15.09
12:58	0.30	16.10
12:59	0.30	13.99
13:00	0.30	12.95
13:01	0.30	13.06
13:02	0.30	13.64
13:03	0.30	15.76
13:04	0.30	15.33
13:05	0.30	14.04
13:06	0.30	14.09
13:07	0.30	14.17
13:08	0.30	14.36
13:09	0.30	15.83
13:10	0.30	14.90
13:11	0.25	16.10
13:12	0.20	16.78
13:13	0.27	16.54
13:14	0.30	16.74
13:15	0.30	16.90
13:16	0.30	16.90
13:17	0.30	16.93
13:18	0.30	16.99
13:19	0.27	17.00
13:20	0.30	17.00
13:21	0.30	16.98
13:22	0.30	16.93
13:23	0.30	16.91
13:24	0.30	16.90
13:25	0.30	16.90
13:26	0.30	16.90
13:27	0.29	16.90
13:28	0.20	16.98
13:29	0.20	16.41
13:30	0.20	14.42

**ASARCO LLC - Hayden Operations****Hayden Smelter - Acid Plant (S2)****O<sub>2</sub>/CO<sub>2</sub> Computer Logger****Hayden, Arizona****12/19/16**

13:31	0.20	13.96
13:32	0.20	13.85
13:33	0.20	13.69
13:34	0.23	13.53
13:35	0.30	13.42
13:36	0.25	13.40
13:37	0.30	13.40
13:38	0.30	13.38
13:39	0.35	13.24
13:40	0.40	13.10
13:41	0.40	12.94
13:42	0.40	12.89
13:43	0.40	12.80
13:44	0.40	12.77
13:45	0.40	12.71
13:46	0.40	12.70
13:47	0.34	12.67
13:48	0.30	12.62
13:49	0.30	12.70
13:50	0.30	12.70
13:51	0.29	12.74
13:52	0.20	13.00
13:53	0.20	13.32
13:54	0.20	13.87
13:55	0.20	12.54
13:56	0.20	13.53
13:57	0.20	14.28
13:58	0.20	13.28
13:59	0.20	11.48
14:00	0.20	11.10
14:01	0.20	11.08
14:02	0.20	10.77
14:03	0.20	10.60
14:04	0.20	10.59
14:05	0.20	12.29
14:06	0.20	13.03
14:07	0.20	13.78
14:08	0.29	14.05
14:09	0.30	13.80
14:10	0.30	13.05
14:11	0.30	12.10
14:12	0.30	12.11
14:13	0.30	12.30
14:14	0.30	12.40

**ASARCO LLC - Hayden Operations****Hayden Smelter - Acid Plant (S2)****O<sub>2</sub>/CO<sub>2</sub> Computer Logger****Hayden, Arizona****12/19/16**

14:15	0.30	12.33
14:16	0.30	12.13
14:17	0.30	11.48
14:18	0.30	10.97
14:19	0.30	11.23
14:20	0.30	11.35
14:21	0.30	10.98
14:22	0.30	11.95
14:23	0.30	12.70
14:24	0.30	12.89
14:25	0.30	12.90
14:26	0.30	12.89
14:27	0.30	12.66
14:28	0.30	12.99
14:29	0.30	11.56
14:30	0.30	10.75
14:31	0.30	10.38
14:32	0.38	10.06
14:33	0.36	10.55
14:34	0.30	10.64
14:35	0.30	10.58
14:36	0.30	11.62
14:37	0.30	12.65
14:38	0.30	13.61
14:39	0.30	14.11
14:40	0.30	14.23
14:41	0.30	13.94
14:42	0.30	13.56
14:43	0.30	13.58
14:44	0.30	13.07
14:45	0.30	12.96
14:46	0.30	12.41
14:47	0.30	12.28
14:48	0.30	12.32
14:49	0.30	12.71
14:50	0.30	13.40
14:51	0.30	14.73
14:52	0.30	15.10
14:53	0.30	15.10
14:54	0.30	15.02
14:55	0.30	14.80
14:56	0.30	14.49
14:57	0.30	15.45
14:58	0.30	15.32

**ASARCO LLC - Hayden Operations****Hayden Smelter - Acid Plant (S2)****O<sub>2</sub>/CO<sub>2</sub> Computer Logger****Hayden, Arizona****12/19/16**

14:59	0.30	14.64
15:00	0.30	14.17
15:01	0.30	14.03
15:02	0.30	13.89
15:03	0.30	13.94
15:04	0.30	14.02
15:05	0.30	14.15
15:06	0.30	14.20
15:07	0.30	14.46
15:08	0.30	14.68
15:09	0.30	14.78
15:10	0.30	13.23
15:11	0.30	12.52
15:12	0.30	11.87
15:13	0.30	11.05
15:14	0.30	10.60
15:15	0.30	11.16
15:16	0.30	11.53
15:17	0.30	11.76
15:18	0.30	12.09
15:19	0.30	12.41
15:20	0.30	12.61
15:21	0.30	12.88
15:22	0.30	13.13
15:23	0.30	13.61
15:24	0.30	13.79
15:25	0.30	13.76
15:26	0.30	13.29
15:27	0.30	13.08
15:28	0.30	13.57
15:29	0.30	16.04
15:30	0.30	16.74
15:31	0.30	16.78
15:32	0.30	15.66
15:33	0.30	14.38
15:34	0.30	13.80
15:35	0.30	13.55
15:36	0.30	13.85
15:37	0.30	13.87
15:38	0.30	13.93
15:39	0.30	16.25
15:40	0.30	15.90
15:41	0.30	14.32
15:42	0.30	14.20

**ASARCO LLC - Hayden Operations****Hayden Smelter - Acid Plant (S2)****O<sub>2</sub>/CO<sub>2</sub> Computer Logger****Hayden, Arizona****12/19/16**

15:43	0.30	14.13
15:44	0.30	14.02
15:45	0.30	13.90
15:46	0.30	13.90
15:47	0.30	13.83
15:48	0.30	13.80
15:49	0.30	13.80
15:50	0.30	13.80
15:51	0.30	13.80
15:52	0.38	13.80
15:53	0.35	13.73
15:54	0.30	13.77
15:55	0.37	13.74
15:56	0.34	13.70
15:57	0.30	13.70
15:58	0.30	13.70
15:59	0.30	13.94
16:00	0.30	14.14
16:01	0.30	13.84
16:02	0.30	13.98
16:03	0.30	14.31
16:04	0.30	13.09
16:05	0.30	11.41
16:06	0.30	11.08
16:07	0.30	10.87
16:08	0.30	10.62
16:09	0.30	10.37
16:10	0.30	10.51
16:11	0.30	11.09
16:12	0.30	11.46
16:13	0.30	11.71
16:14	0.30	11.90
16:15	0.30	11.98
16:16	0.30	12.26
16:17	0.30	12.74
16:18	0.30	12.83
16:19	0.30	12.56
16:20	0.30	12.41
16:21	0.30	12.23
16:22	0.31	12.45
16:23	0.30	13.26
16:24	0.30	13.53
16:25	0.30	13.57
16:26	0.30	14.30

**ASARCO LLC - Hayden Operations**

**Hayden Smelter - Acid Plant (S2)**

**O<sub>2</sub>/CO<sub>2</sub> Computer Logger**

**Hayden, Arizona**

**12/19/16**

16:27	0.30	14.44	
16:28	0.30	13.91	
16:29	0.30	12.81	
16:30	0.30	12.19	
16:31	0.30	12.09	
16:32	0.30	12.29	
16:33	0.30	12.62	
16:34	0.30	12.89	
16:35	0.30	13.16	
16:36	0.30	13.06	
16:37	0.30	14.23	
16:38	0.30	13.22	
16:39	0.30	13.06	
16:40	0.30	13.60	
16:41	0.30	13.85	
16:42	0.30	13.97	
16:43	0.30	13.44	
16:44	0.20	14.31	
16:45	0.20	15.20	
16:46	0.30	13.48	
16:47	0.30	12.51	
16:48	0.30	13.67	
16:49	0.30	14.49	
16:50	0.30	13.66	
16:51	0.30	14.01	
16:52	0.30	14.13	
16:53	0.30	14.66	
16:54	0.30	14.98	
16:55	0.30	13.66	
16:56	0.30	13.99	
16:57	0.30	14.67	
16:58	0.30	14.30	
16:59	0.30	14.13	
17:00	0.30	14.20	
17:01	0.30	15.06	
17:02	0.30	15.22	
17:03	0.30	15.11	
17:04	0.30	16.31	
17:05	0.30	16.50	End Run 1
17:06	0.30	16.60	
17:07	0.30	16.91	
17:08	0.78	13.61	
17:09	<u>0.03</u>	<u>0.53</u>	
17:10	0.00	0.48	

**ASARCO LLC - Hayden Operations**

**Hayden Smelter - Acid Plant (S2)**

**O<sub>2</sub>/CO<sub>2</sub> Computer Logger**

**Hayden, Arizona**

**12/19/16**

17:11	0.00	0.49
17:12	0.07	0.62
17:13	10.36	10.09
17:14	<u>11.16</u>	<u>10.80</u>
17:15	11.15	10.87

**ASARCO LLC - Hayden Operations**  
**Hayden Smelter - Acid Plant (S2)**  
**O<sub>2</sub>/CO<sub>2</sub> Computer Logger**

**Hayden, Arizona**  
**12/20/16**

<b>Time</b>	<b>CO<sub>2</sub> %vd</b>	<b>O<sub>2</sub> %vd</b>	<b>Comments</b>
07:48	2.30	18.07	Instrument/Calibration Tank IDs/Run Times
07:49	0.10	19.86	
07:50	0.09	No Data	<b>O<sub>2</sub>, Tank IDs:</b>
07:51	0.00	No Data	CC268790 @ 11.03%vd; Exp. 06/10/24
07:52	<u>0.00</u>	<u>-0.06</u>	SA15470 @ 20.99%vd; Exp. 05/12/23
07:53	0.00	-0.08	O <sub>2</sub> Instrument: Servomex 1400
07:54	0.00	-0.10	
07:55	5.86	5.25	<b>CO<sub>2</sub>, Tank IDs:</b>
07:56	20.59	21.64	CC268790 @ 10.99%vd; Exp. 06/10/24
07:57	20.30	21.67	SA15470 @ 19.49%vd; Exp. 05/12/23
07:58	19.70	21.20	CO <sub>2</sub> Instrument: Servomex 1440
07:59	<u>19.43</u>	<u>21.03</u>	
08:00	16.50	19.31	
08:01	10.90	11.10	
08:02	<u>10.90</u>	<u>11.00</u>	
08:03	10.87	11.00	
08:04	10.81	11.00	
08:05	10.59	11.00	
08:06	0.65	14.63	
08:07	0.21	15.40	
08:08	0.50	4.53	
08:09	0.00	0.44	
08:10	<u>0.00</u>	<u>0.14</u>	
08:11	0.00	0.02	
08:12	0.00	0.03	
08:13	2.10	2.07	
08:14	10.52	10.11	
08:15	10.94	10.81	
08:16	<u>10.91</u>	<u>11.11</u>	
08:17	10.90	11.15	
08:18	10.72	11.32	
08:19	1.85	14.93	
08:20	0.36	15.15	
08:21	0.30	15.19	
08:22	0.30	15.28	
08:23	0.30	16.43	
08:24	0.30	16.21	
08:25	0.30	13.57	
08:26	0.30	12.97	
08:27	0.17	17.48	

**ASARCO LLC - Hayden Operations  
Hayden Smelter - Acid Plant (S2)  
O<sub>2</sub>/CO<sub>2</sub> Computer Logger**

**Hayden, Arizona  
12/20/16**

<b>Time</b>	<b>CO<sub>2</sub> %vd</b>	<b>O<sub>2</sub> %vd</b>	<b>Comments</b>
08:28	0.10	20.61	
08:29	0.17	19.55	
08:30	0.30	17.51	
08:31	0.26	17.21	
08:32	0.30	16.00	
08:33	0.21	16.06	
08:34	0.57	15.71	
08:35	0.49	1.73	
08:36	0.00	0.10	
08:37	0.00	-0.14	
08:38	0.00	-0.12	
08:39	1.93	2.28	
08:40	9.17	10.59	
08:41	10.81	10.95	
08:42	11.03	10.95	
08:43	11.03	10.97	
08:44	10.28	11.48	
08:45	5.09	14.30	
08:46	0.55	17.35	
08:47	0.44	17.40	
08:48	0.40	17.48	Begin Run 2
08:49	0.40	17.50	
08:50	0.40	17.40	
08:51	0.40	17.43	
08:52	0.40	17.50	
08:53	0.30	17.54	
08:54	0.30	17.55	
08:55	0.30	15.82	
08:56	0.30	15.33	
08:57	0.30	14.32	
08:58	0.30	13.28	
08:59	0.37	13.85	
09:00	0.40	14.29	
09:01	0.39	14.45	
09:02	0.40	14.51	
09:03	0.40	14.47	
09:04	0.40	14.34	
09:05	0.40	14.92	
09:06	0.40	16.61	
09:07	0.33	17.08	
09:08	0.30	16.48	

**ASARCO LLC - Hayden Operations**  
**Hayden Smelter - Acid Plant (S2)**  
**O<sub>2</sub>/CO<sub>2</sub> Computer Logger**

**Hayden, Arizona**  
**12/20/16**

<b>Time</b>	<b>CO<sub>2</sub> %vd</b>	<b>O<sub>2</sub> %vd</b>	<b>Comments</b>
09:09	0.30	16.01	
09:10	0.30	15.95	
09:11	0.30	15.66	
09:12	0.33	15.15	
09:13	0.39	14.77	
09:14	0.30	14.83	
09:15	0.30	14.81	
09:16	0.30	14.62	
09:17	0.39	13.06	
09:18	0.40	12.36	
09:19	0.31	12.11	
09:20	0.32	12.19	
09:21	0.40	12.13	
09:22	0.40	12.10	
09:23	0.40	11.92	
09:24	0.40	11.89	
09:25	0.40	11.85	
09:26	0.40	11.79	
09:27	0.40	11.75	
09:28	0.40	11.62	
09:29	0.40	11.76	
09:30	0.40	11.93	
09:31	0.36	12.36	
09:32	0.30	13.11	
09:33	0.30	14.49	
09:34	0.30	13.41	
09:35	0.30	13.18	
09:36	0.30	13.75	
09:37	0.30	13.97	
09:38	0.30	14.20	
09:39	0.30	13.76	
09:40	0.30	13.29	
09:41	0.30	12.90	
09:42	0.30	13.31	
09:43	0.29	13.79	
09:44	0.20	15.44	
09:45	0.20	16.91	
09:46	0.21	17.41	
09:47	0.30	16.23	
09:48	0.30	16.10	
09:49	0.30	16.15	

**ASARCO LLC - Hayden Operations  
Hayden Smelter - Acid Plant (S2)  
O<sub>2</sub>/CO<sub>2</sub> Computer Logger**

**Hayden, Arizona  
12/20/16**

<b>Time</b>	<b>CO<sub>2</sub> %vd</b>	<b>O<sub>2</sub> %vd</b>	<b>Comments</b>
09:50	0.30	16.20	
09:51	0.30	16.20	
09:52	0.30	16.09	
09:53	0.30	15.57	
09:54	0.30	15.33	
09:55	0.30	15.09	
09:56	0.30	15.22	
09:57	0.30	15.47	
09:58	0.30	15.71	
09:59	0.30	15.83	
10:00	0.30	15.97	
10:01	0.30	16.08	
10:02	0.30	15.54	
10:03	0.30	14.96	
10:04	0.30	14.69	
10:05	0.30	14.96	
10:06	0.30	14.86	
10:07	0.30	14.71	
10:08	0.30	14.61	
10:09	0.30	14.80	
10:10	0.30	14.95	
10:11	0.30	15.01	
10:12	0.30	15.16	
10:13	0.30	15.30	
10:14	0.30	15.72	
10:15	0.30	17.03	
10:16	0.30	17.32	
10:17	0.30	16.84	
10:18	0.30	15.33	
10:19	0.30	13.65	
10:20	0.30	12.53	
10:21	0.30	12.23	
10:22	0.30	12.58	
10:23	0.30	13.70	
10:24	0.30	14.21	
10:25	0.30	14.55	
10:26	0.30	14.89	
10:27	0.30	15.10	
10:28	0.30	15.32	
10:29	0.30	15.48	
10:30	0.30	16.18	

**ASARCO LLC - Hayden Operations**  
**Hayden Smelter - Acid Plant (S2)**  
**O<sub>2</sub>/CO<sub>2</sub> Computer Logger**

**Hayden, Arizona**  
**12/20/16**

<b>Time</b>	<b>CO<sub>2</sub> %vd</b>	<b>O<sub>2</sub> %vd</b>	<b>Comments</b>
10:31	0.30	17.19	
10:32	0.30	17.30	
10:33	0.30	16.12	
10:34	0.30	15.33	
10:35	0.30	14.45	
10:36	0.30	14.08	
10:37	0.30	13.95	
10:38	0.27	13.92	
10:39	0.24	14.18	
10:40	0.29	13.93	
10:41	0.16	14.59	
10:42	0.10	15.46	
10:43	0.21	15.24	
10:44	0.36	14.18	
10:45	0.30	14.01	
10:46	0.30	14.10	
10:47	0.30	14.05	
10:48	0.30	13.90	
10:49	0.30	13.99	
10:50	0.30	14.00	
10:51	0.31	13.92	
10:52	0.38	13.83	
10:53	0.30	13.79	
10:54	0.30	13.82	
10:55	0.30	14.00	
10:56	0.27	14.17	
10:57	0.20	14.28	
10:58	0.25	14.18	
10:59	0.30	13.73	
11:00	0.30	13.50	
11:01	0.30	13.59	
11:02	0.30	14.50	
11:03	0.30	16.49	
11:04	0.30	16.36	
11:05	0.30	15.41	
11:06	0.30	13.60	
11:07	0.30	12.27	
11:08	0.30	12.00	
11:09	0.30	11.84	
11:10	0.30	11.74	
11:11	0.30	11.78	

**ASARCO LLC - Hayden Operations  
Hayden Smelter - Acid Plant (S2)  
O<sub>2</sub>/CO<sub>2</sub> Computer Logger**

**Hayden, Arizona  
12/20/16**

<b>Time</b>	<b>CO<sub>2</sub> %vd</b>	<b>O<sub>2</sub> %vd</b>	<b>Comments</b>
11:12	0.40	11.60	
11:13	0.40	11.75	
11:14	0.40	11.61	
11:15	0.30	12.11	
11:16	0.30	13.77	
11:17	0.30	14.56	
11:18	0.30	15.76	
11:19	0.30	16.09	
11:20	0.30	15.35	
11:21	0.30	15.30	
11:22	0.30	15.30	
11:23	0.30	15.30	
11:24	0.30	15.38	
11:25	0.30	15.45	
11:26	0.30	15.52	
11:27	0.30	15.51	
11:28	0.30	15.20	
11:29	0.30	15.20	
11:30	0.30	15.20	
11:31	0.30	15.44	
11:32	0.30	15.61	
11:33	0.30	15.67	
11:34	0.30	14.66	
11:35	0.30	14.33	
11:36	0.30	14.18	
11:37	0.30	13.86	
11:38	0.30	13.85	
11:39	0.30	13.64	
11:40	0.30	13.75	
11:41	0.30	14.16	
11:42	0.30	13.91	
11:43	0.30	13.69	
11:44	0.30	13.70	
11:45	0.30	13.30	
11:46	0.30	13.29	
11:47	0.30	13.28	
11:48	0.30	13.15	
11:49	0.30	14.43	
11:50	0.30	14.89	
11:51	0.30	13.79	
11:52	0.30	13.49	

**ASARCO LLC - Hayden Operations  
Hayden Smelter - Acid Plant (S2)  
O<sub>2</sub>/CO<sub>2</sub> Computer Logger**

**Hayden, Arizona  
12/20/16**

<b>Time</b>	<b>CO<sub>2</sub> %vd</b>	<b>O<sub>2</sub> %vd</b>	<b>Comments</b>
11:53	0.30	14.79	
11:54	0.30	15.24	
11:55	0.30	15.93	
11:56	0.30	15.72	
11:57	0.30	14.32	
11:58	0.30	13.76	
11:59	0.29	13.81	
12:00	0.20	13.98	
12:01	0.20	13.96	
12:02	0.20	13.68	
12:03	0.20	13.42	
12:04	0.20	13.57	
12:05	0.20	13.47	
12:06	0.20	13.41	
12:07	0.20	13.49	
12:08	0.20	13.63	
12:09	0.20	14.82	
12:10	0.20	15.55	
12:11	0.20	16.91	
12:12	0.20	15.87	
12:13	0.20	15.42	
12:14	0.20	15.44	
12:15	0.26	15.08	
12:16	0.30	15.00	
12:17	0.30	14.95	
12:18	0.27	15.03	
12:19	0.20	15.52	
12:20	0.20	16.15	
12:21	0.20	15.35	
12:22	0.20	14.11	
12:23	0.22	13.49	
12:24	0.30	12.89	
12:25	0.30	12.79	
12:26	0.30	12.76	
12:27	0.30	12.85	
12:28	0.30	14.18	
12:29	0.30	14.88	
12:30	0.30	15.04	
12:31	0.30	16.22	
12:32	0.30	15.63	
12:33	0.30	14.59	

**ASARCO LLC - Hayden Operations**  
**Hayden Smelter - Acid Plant (S2)**  
**O<sub>2</sub>/CO<sub>2</sub> Computer Logger**

**Hayden, Arizona**  
**12/20/16**

<b>Time</b>	<b>CO<sub>2</sub> %vd</b>	<b>O<sub>2</sub> %vd</b>	<b>Comments</b>
12:34	0.30	14.40	
12:35	0.30	14.39	
12:36	0.30	14.73	
12:37	0.30	14.83	
12:38	0.24	13.99	
12:39	0.30	12.74	
12:40	0.30	12.76	
12:41	0.30	12.67	
12:42	0.30	12.24	
12:43	0.30	12.34	
12:44	0.30	13.72	
12:45	0.30	14.14	
12:46	0.30	13.87	
12:47	0.30	13.53	
12:48	0.30	13.50	
12:49	0.30	13.82	
12:50	0.30	14.05	
12:51	0.30	13.64	
12:52	0.30	13.24	
12:53	0.30	13.10	
12:54	0.30	13.09	
12:55	0.30	13.31	
12:56	0.30	14.59	
12:57	0.30	14.99	
12:58	0.30	15.00	
12:59	0.30	15.01	
13:00	0.30	15.24	
13:01	0.30	15.17	
13:02	0.30	15.06	
13:03	0.30	14.86	
13:04	0.30	15.19	
13:05	0.30	16.98	
13:06	0.30	17.39	
13:07	0.30	17.57	
13:08	0.30	17.61	
13:09	0.30	17.74	
13:10	0.30	17.71	
13:11	0.30	17.60	
13:12	0.30	17.53	
13:13	0.30	17.48	
13:14	0.30	17.36	

**ASARCO LLC - Hayden Operations**  
**Hayden Smelter - Acid Plant (S2)**  
**O<sub>2</sub>/CO<sub>2</sub> Computer Logger**

**Hayden, Arizona**  
**12/20/16**

<b>Time</b>	<b>CO<sub>2</sub> %vd</b>	<b>O<sub>2</sub> %vd</b>	<b>Comments</b>
13:15	0.30	17.38	
13:16	0.30	17.30	
13:17	0.30	17.35	
13:18	0.30	16.47	
13:19	0.30	14.97	
13:20	0.30	14.98	
13:21	0.30	14.92	
13:22	0.24	14.59	
13:23	0.30	14.39	
13:24	0.30	14.52	
13:25	0.30	14.65	
13:26	0.30	14.70	
13:27	0.30	14.71	
13:28	0.30	14.21	
13:29	0.30	13.57	End Run 2
13:30	0.30	13.52	
13:31	0.30	13.97	
13:32	0.26	14.00	
13:33	0.83	7.24	
13:34	0.03	0.52	
13:35	0.00	0.49	
13:36	0.00	0.32	
13:37	<u>0.00</u>	<u>0.15</u>	
13:38	0.00	0.19	
13:39	4.62	4.37	
13:40	<u>10.87</u>	<u>10.61</u>	
13:41	11.13	10.59	
13:42	11.19	10.54	
13:43	11.10	10.68	
13:44	9.84	11.60	
13:45	3.28	13.17	
13:46	0.47	13.20	
13:47	0.40	12.38	
13:48	0.40	12.05	
13:49	0.32	13.82	
13:50	0.30	14.29	
13:51	0.30	14.55	
13:52	0.30	14.69	
13:53	0.30	14.51	
13:54	0.30	12.76	
13:55	0.24	12.97	

**ASARCO LLC - Hayden Operations**  
**Hayden Smelter - Acid Plant (S2)**  
**O<sub>2</sub>/CO<sub>2</sub> Computer Logger**

**Hayden, Arizona**  
**12/20/16**

<b>Time</b>	<b>CO<sub>2</sub> %vd</b>	<b>O<sub>2</sub> %vd</b>	<b>Comments</b>
13:56	0.30	13.17	
13:57	0.30	13.81	
13:58	0.30	15.05	
13:59	0.30	15.18	
14:00	0.30	15.28	
14:01	0.30	15.46	
14:02	0.30	15.31	
14:03	0.30	14.12	
14:04	0.30	15.07	
14:05	0.30	15.51	
14:06	0.30	16.39	
14:07	0.30	16.70	
14:08	0.30	14.71	
14:09	0.30	14.17	
14:10	0.30	13.50	
14:11	0.30	13.93	
14:12	0.30	13.94	
14:13	0.30	12.86	
14:14	0.30	13.27	Begin Run 3
14:15	0.30	13.82	
14:16	0.30	13.89	
14:17	0.30	14.00	
14:18	0.30	13.70	
14:19	0.30	13.58	
14:20	0.30	13.51	
14:21	0.30	13.50	
14:22	0.30	13.50	
14:23	0.30	13.50	
14:24	0.30	13.49	
14:25	0.30	13.48	
14:26	0.30	13.42	
14:27	0.30	13.41	
14:28	0.31	13.03	
14:29	0.30	12.92	
14:30	0.30	13.59	
14:31	0.30	14.54	
14:32	0.30	14.60	
14:33	0.30	14.60	
14:34	0.30	14.61	
14:35	0.30	14.63	
14:36	0.30	14.63	

**ASARCO LLC - Hayden Operations**  
**Hayden Smelter - Acid Plant (S2)**  
**O<sub>2</sub>/CO<sub>2</sub> Computer Logger**

**Hayden, Arizona**  
**12/20/16**

<b>Time</b>	<b>CO<sub>2</sub> %vd</b>	<b>O<sub>2</sub> %vd</b>	<b>Comments</b>
14:37	0.30	14.63	
14:38	0.30	14.62	
14:39	0.30	14.70	
14:40	0.30	14.70	
14:41	0.30	14.70	
14:42	0.30	14.74	
14:43	0.30	14.75	
14:44	0.30	14.67	
14:45	0.30	14.90	
14:46	0.30	14.85	
14:47	0.30	14.93	
14:48	0.30	15.35	
14:49	0.30	14.62	
14:50	0.30	13.82	
14:51	0.30	15.72	
14:52	0.30	17.16	
14:53	0.30	17.33	
14:54	0.30	17.48	
14:55	0.30	17.52	
14:56	0.30	17.44	
14:57	0.30	17.47	
14:58	0.30	17.73	
14:59	0.30	17.65	
15:00	0.30	17.57	
15:01	0.30	16.78	
15:02	0.30	16.38	
15:03	0.30	16.34	
15:04	0.30	16.33	
15:05	0.30	14.80	
15:06	0.30	13.19	
15:07	0.30	12.49	
15:08	0.30	11.66	
15:09	0.30	11.25	
15:10	0.26	13.53	
15:11	0.20	14.68	
15:12	0.20	14.72	
15:13	0.20	14.69	
15:14	0.22	14.82	
15:15	0.30	13.19	
15:16	0.30	11.88	
15:17	0.30	11.88	

**ASARCO LLC - Hayden Operations  
Hayden Smelter - Acid Plant (S2)  
O<sub>2</sub>/CO<sub>2</sub> Computer Logger**

**Hayden, Arizona  
12/20/16**

<b>Time</b>	<b>CO<sub>2</sub> %vd</b>	<b>O<sub>2</sub> %vd</b>	<b>Comments</b>
15:18	0.30	11.95	
15:19	0.30	12.06	
15:20	0.30	12.36	
15:21	0.30	12.51	
15:22	0.30	12.56	
15:23	0.30	12.74	
15:24	0.30	12.94	
15:25	0.30	12.93	
15:26	0.30	13.23	
15:27	0.30	13.39	
15:28	0.30	13.25	
15:29	0.30	13.57	
15:30	0.30	13.90	
15:31	0.30	14.07	
15:32	0.30	13.63	
15:33	0.30	13.24	
15:34	0.30	13.44	
15:35	0.30	15.31	
15:36	0.30	15.81	
15:37	0.30	15.86	
15:38	0.30	17.03	
15:39	0.30	17.40	
15:40	0.30	17.43	
15:41	0.30	17.44	
15:42	0.30	16.73	
15:43	0.30	15.22	
15:44	0.30	14.99	
15:45	0.30	14.84	
15:46	0.30	14.97	
15:47	0.24	15.23	
15:48	0.20	15.35	
15:49	0.20	15.52	
15:50	0.29	15.50	
15:51	0.30	15.22	
15:52	0.30	15.00	
15:53	0.29	14.75	
15:54	0.20	15.14	
15:55	0.20	15.02	
15:56	0.20	14.95	
15:57	0.20	13.79	
15:58	0.20	13.76	

**ASARCO LLC - Hayden Operations**  
**Hayden Smelter - Acid Plant (S2)**  
**O<sub>2</sub>/CO<sub>2</sub> Computer Logger**

**Hayden, Arizona**  
**12/20/16**

<b>Time</b>	<b>CO<sub>2</sub> %vd</b>	<b>O<sub>2</sub> %vd</b>	<b>Comments</b>
15:59	0.23	13.45	
16:00	0.26	12.56	
16:01	0.30	12.18	
16:02	0.30	11.82	
16:03	0.30	11.49	
16:04	0.30	11.54	
16:05	0.30	11.53	
16:06	0.30	11.28	
16:07	0.30	12.61	
16:08	0.30	13.00	
16:09	0.30	13.18	
16:10	0.30	13.17	
16:11	0.30	13.13	
16:12	0.30	13.24	
16:13	0.30	13.31	
16:14	0.30	14.08	
16:15	0.30	15.54	
16:16	0.30	15.61	
16:17	0.30	15.94	
16:18	0.30	17.16	
16:19	0.30	17.40	
16:20	0.30	17.39	
16:21	0.30	17.50	
16:22	0.30	17.41	
16:23	0.30	15.92	
16:24	0.30	13.93	
16:25	0.30	13.06	
16:26	0.30	13.07	
16:27	0.30	15.91	
16:28	0.30	16.59	
16:29	0.30	17.21	
16:30	0.30	17.49	
16:31	0.30	17.53	
16:32	0.30	17.55	
16:33	0.30	17.35	
16:34	0.30	17.47	
16:35	0.30	17.40	
16:36	0.30	17.37	
16:37	0.33	17.40	
16:38	0.40	17.37	
16:39	0.32	17.30	

**ASARCO LLC - Hayden Operations  
Hayden Smelter - Acid Plant (S2)  
O<sub>2</sub>/CO<sub>2</sub> Computer Logger**

**Hayden, Arizona  
12/20/16**

<b>Time</b>	<b>CO<sub>2</sub> %vd</b>	<b>O<sub>2</sub> %vd</b>	<b>Comments</b>
16:40	0.30	17.30	
16:41	0.30	17.30	
16:42	0.30	17.26	
16:43	0.30	17.21	
16:44	0.30	17.21	
16:45	0.30	17.20	
16:46	0.30	17.20	
16:47	0.30	17.20	
16:48	0.30	17.19	
16:49	0.30	17.20	
16:50	0.30	17.20	
16:51	0.30	17.22	
16:52	0.30	17.26	
16:53	0.30	17.20	
16:54	0.30	17.20	
16:55	0.30	17.20	
16:56	0.30	17.19	
16:57	0.30	17.14	
16:58	0.30	17.20	
16:59	0.30	17.24	
17:00	0.30	17.30	
17:01	0.30	17.30	
17:02	0.30	17.35	
17:03	0.30	17.40	
17:04	0.30	17.40	
17:05	0.30	17.32	
17:06	0.30	15.31	
17:07	0.30	14.32	
17:08	0.30	14.67	
17:09	0.30	15.08	
17:10	0.30	14.89	
17:11	0.30	14.23	
17:12	0.30	14.62	
17:13	0.30	14.57	
17:14	0.30	13.53	
17:15	0.30	12.87	
17:16	0.30	11.94	
17:17	0.30	12.11	
17:18	0.30	12.95	
17:19	0.30	13.24	
17:20	0.30	13.55	

**ASARCO LLC - Hayden Operations  
Hayden Smelter - Acid Plant (S2)  
O<sub>2</sub>/CO<sub>2</sub> Computer Logger**

**Hayden, Arizona  
12/20/16**

<b>Time</b>	<b>CO<sub>2</sub> %vd</b>	<b>O<sub>2</sub> %vd</b>	<b>Comments</b>
17:21	0.30	12.59	
17:22	0.30	11.60	
17:23	0.30	11.48	
17:24	0.30	11.73	
17:25	0.30	12.06	
17:26	0.30	12.67	
17:27	0.30	13.35	
17:28	0.30	13.24	
17:29	0.30	12.62	
17:30	0.30	11.83	
17:31	0.30	11.79	
17:32	0.30	11.93	
17:33	0.30	12.07	
17:34	0.30	12.49	
17:35	0.30	12.92	
17:36	0.28	13.41	
17:37	0.20	13.69	
17:38	0.20	13.90	
17:39	0.20	15.01	
17:40	0.20	15.48	
17:41	0.20	17.08	
17:42	0.28	17.39	
17:43	0.30	17.39	
17:44	0.30	17.50	
17:45	0.30	17.50	
17:46	0.30	17.50	
17:47	0.30	17.57	
17:48	0.30	17.58	
17:49	0.30	17.41	
17:50	0.33	17.37	
17:51	0.33	17.40	
17:52	0.34	17.36	
17:53	0.32	17.47	
17:54	0.29	16.76	
17:55	0.30	16.00	
17:56	0.30	15.49	
17:57	0.24	14.91	
17:58	0.20	14.29	
17:59	0.20	14.09	
18:00	0.25	13.94	
18:01	0.30	13.78	

**ASARCO LLC - Hayden Operations**  
**Hayden Smelter - Acid Plant (S2)**  
**O<sub>2</sub>/CO<sub>2</sub> Computer Logger**

**Hayden, Arizona**  
**12/20/16**

<b>Time</b>	<b>CO<sub>2</sub> %vd</b>	<b>O<sub>2</sub> %vd</b>	<b>Comments</b>
18:02	0.30	13.61	
18:03	0.30	13.48	
18:04	0.30	13.40	
18:05	0.30	13.33	
18:06	0.30	13.30	
18:07	0.30	13.22	
18:08	0.30	13.20	
18:09	0.30	13.20	
18:10	0.30	13.23	
18:11	0.30	13.25	
18:12	0.30	13.37	
18:13	0.30	13.20	
18:14	0.30	13.01	
18:15	0.30	13.32	
18:16	0.30	14.37	
18:17	0.30	14.60	
18:18	0.30	14.70	
18:19	0.30	14.90	
18:20	0.30	15.06	
18:21	0.30	15.14	
18:22	0.30	15.47	
18:23	0.30	15.67	
18:24	0.29	15.96	
18:25	0.20	16.23	End Run 3
18:26	0.20	16.34	
18:27	0.20	15.96	
18:28	0.59	14.73	
18:29	0.39	1.65	
18:30	0.00	-0.45	
18:31	<u>0.00</u>	<u>-0.43</u>	
18:32	0.00	-0.19	
18:33	5.10	4.49	
18:34	<u>11.11</u>	<u>10.43</u>	
18:35	11.26	10.45	

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## EQUIPMENT CALIBRATION

**ASARCO Hayden Operations - Hayden Smelter  
Acid Plant  
Hayden, Arizona**

**12/19,20/16**

1) Meter Box

**SB-2**

12/05/16	@	0.9976 (Full Profile from manufacturer - new meterbox)
12/21/16	@	0.999 (@ 1.75 "H <sub>2</sub> O Delta H and 15.0 "Hg Vacuum)

2) Thermocouple (SB-1) and Dial Thermometers

Note included data sheets for pre and post calibration data.

3) Pitot tube (1068255)

Note included sheets for pre and post calibration data.

4) Barometer (aneroid)

The aneroid barometer was calibrated with a mercury wall barometer prior to and after the test series. See included data sheet.

5) Nozzles (Glass, 10A, 10B)

The nozzles were measured by a Precise Starrett expanding micrometer and micro-calipers. The calibration sheet is included in this section.

6) Instrument Calibration Gases

EPA Protocol 1 Calibration Gases were utilized for instrument calibrations. Copies of the span gas certificates are included in this section.

**Meter Console Information**

Model #: XC-522  
 Serial #: 1602002  
 DGM Model #: S-110  
 DGM Serial #: 1503533  
 Bar. Pressure (in Hg): 30.00  
 Ambient Temp (°F): 75.6  
 Relative Humidity (%): 53  
 Altitude (ft): 414.0  
 Altitude Correction Factor (in): -0.414  
 Corrected Bar. Pressure (in Hg): 29.59

### Certificate of Calibration

METHOD 5 PRE-TEST CONSOLE CALIBRATION

Calibration Conditions  
 Factors/Conversions  
 Std Temp (R): 527.67  
 Std Press (in Hg): 29.92  
 K<sub>1</sub> (R/in Hg): 17.636

Reference Equipment  
 WTM Model: AL-20 WTM Serial: 11AE6  
 WTM Cal. Due Date: Dec-16 Gamma: 0.9999  
 WTM Thermometer: Hg

Bison Engineering-AZ

Test Meter (DGM)						
Run Time, min	Orifice, AH (in H <sub>2</sub> O)	Volume (cubic feet)			Outlet Temp (°F)	
		Initial	Final	Total	Initial	Final
θ	P <sub>m</sub>	V <sub>m</sub>	V <sub>m'</sub>	V <sub>m</sub>	t <sub>m</sub>	t <sub>m'</sub>
5.0	5.0	10.005	16.303	6.298	76	77
6.0	3.0	22.105	27.958	5.853	77	78
7.0	2.0	27.958	33.520	5.562	78	79
10.0	1.0	33.520	39.090	5.570	79	80
15.0	0.5	16.303	22.105	5.802	77	77

Reference Meter						
Meter Pressure (in H <sub>2</sub> O)	Volume (cubic feet)			Outlet Temp (°F)		
	Initial	Final	Total	Initial	Final	
P <sub>w</sub>	V <sub>w</sub>	V <sub>w'</sub>	V <sub>w</sub>	t <sub>w</sub>	t <sub>w'</sub>	
2.5	120.990	127.210	6.220	69	69	
2.3	132.910	138.650	5.740	69	69	
2.0	138.650	144.100	5.450	69	69	
1.9	144.100	149.550	5.450	69	69	
1.8	127.210	132.910	5.700	69	69	

**Standardized Data**

Test Meter	Reference Meter	Correction Factor		Flow Rate, Std & Corr		
Std. Volume	Std. Flow Rate	Std. Volume	Std. Flow Rate	Value	Variance	Qm <sub>std, corr</sub>
V <sub>m</sub> (ft <sup>3</sup> )	Q <sub>m</sub> (ft <sup>3</sup> /min)	V <sub>w</sub> (ft <sup>3</sup> )	Q <sub>w</sub> (ft <sup>3</sup> /min)	(Y)	(ΔY)	Q <sub>m, std, corr</sub>
6.20513	1.241	6.17646	1.235	0.9954	-0.002	1.235
5.72769	0.955	5.69700	0.950	0.9946	-0.003	0.950
5.41941	0.774	5.40516	0.772	0.9974	0.000	0.772
5.40374	0.540	5.40383	0.540	1.0000	0.002	0.540
5.64803	0.377	5.65031	0.377	1.0004	0.003	0.377
				0.9976	= Y Avg.	

ΔH @ (in H <sub>2</sub> O)	Variance
0.75 SCFM	
ΔH@	ΔΔH@
1.839	-0.038
1.853	-0.024
1.857	-0.019
1.886	0.010
1.947	0.071
1.876	= ΔH@ Avg.

Note: For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is ± 0.02.

Note: For ΔH<sub>o</sub>, office pressure differential that equates to 0.75cfm (0.0212m<sup>3</sup>/min) at standard temperature and pressure, acceptable tolerance of individual values from the average is ± 0.2 inches (5.1mm) H<sub>2</sub>O.

Pass/Fail Result: **Pass**

The instruments listed and described on this certificate have been calibrated against standards traceable to the National Institute of Standards and Technology (N.I.S.T.).

Technician: Eric Waters

Signature:

Date: 12/5/16



**Meter Box Calibration Orifice Method**  
**APEX INSTRUMENTS 522 Series**  
**English Meter Box Units, English K' Factor**

**Meter Box:** SB-2  
**Calibration Date:** 12/21/16  
**Barometric Pressure:** 27.28 " Hg  
**Theoretical Critical Vacuum:** 12.87 " Hg

CRITICAL ORIFICE READINGS			AMBIENT TEMPERATURE			
$\Delta H$ ( $" H_2O$ )	Orifice Serial #	K' Orifice Coefficient	Initial (°F)	Final (°F)	Average (°F)	Temp (°R)
1.75	63	0.584	63.0	63.0	63.0	523.0
1.75	63	0.584	63.0	63.0	63.0	523.0
1.75	63	0.584	64.0	64.0	64.0	524.0

**CONVERSION FACTORS**

1 mm Hg = 0.13330 kPa  
1 cm = 0.39370 inch  
1 mm = 0.03937 inch  
1 ft<sup>3</sup> = 28.32 liters

Time (min)	Volume Initial (ft <sup>3</sup> )	Volume Final (ft <sup>3</sup> )	Volume Total (ft <sup>3</sup> )	Initial Temps.		Final Temps.		Avg. Temp. Overall (°R)	Avg. Outlet (°R)	Actual Vacuum ( $" Hg$ )
				Inlet (°F)	Outlet (°F)	Inlet (°F)	Outlet (°F)			
6.66	513.112	518.115	5.003	60.0	60.0	60.0	60.0	520.0	520.0	15.0
6.65	518.120	523.123	5.003	61.0	61.0	61.0	61.0	521.0	521.0	15.0
6.68	523.125	528.130	5.005	61.0	61.0	62.0	62.0	521.5	521.5	15.0



Meter Box: SB-2  
Calibration Date: 12/21/16

## CALCULATIONS AND RESULTS

DRY GAS METER		ORIFICE			CALIBRATION FACTOR				
Vm(std) - corrected		Vcr(std) - corrected		Vcr - nominal	Y Value	Variation	ΔH@ Value		Variation
(ft³)	(liters)	(ft³)	(liters)	(ft³)	(#)	(#)	(" H₂O)	(mm H₂O)	(" H₂O)
4.652	131.7	4.640	131.4	5.042	0.997	-1.6E-03	1.878	47.70	0.002
4.643	131.5	4.633	131.2	5.035	0.998	-1.2E-03	1.874	47.61	-0.002
4.640	131.4	4.649	131.7	5.062	1.002	2.9E-03	1.876	47.65	0.000
<b>Averages</b>					<b>0.999</b>		<b>1.876</b>	<b>47.65</b>	

- Notes:
- For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is +-0.02.
  - For Orifice Calibration Factor ΔH@, the orifice differential pressure in inches of H₂O that equates to 0.75 cfm of air at 68 °F and 29.92 "Hg, acceptable tolerance of individual values from the average is +-0.2.
  - For valid test results, the Actual Vacuum should be 1 to 2 "Hg greater than the Theoretical Critical Vacuum shown above.
  - The Critical Orifice Coefficient, K', must be entered in English units,  $(Vm, \text{ft}^3)(\text{SQRT}(Tm \text{ °R})) / ((Pb \text{ "Hg})(\text{min}))$ .

SIGNED:

Date:



## TEMPERATURE DISPLAY CALIBRATION DATA SHEET

Unit: XC-522 Serial #: 1602002  
 Date: December 5, 2016 ThermoCouple: PIE 520-K  
 Personnel: SA Reference#: 105795

Reference Point Number	Reference Thermometer Temperature		Thermocouple Display Temperature		Absolute Temp. Difference
	°C	°F	°C	°F	
1	38	100		100.0	0.00
2	93	200		202.0	0.42
3	149	300		302.0	0.35
4	260	500		499.0	0.13
5	371	700		701.0	0.10
6	482	900		900.0	0.00
7	593	1100		1101.0	0.07
8	816	1500		1499.0	0.06
9	1038	1900		1900.0	0.00
10					
11					
12					
					<b>0.126</b>
					<1.5

NIST Reference TC ID: 90728323

	Theoretical Temperature	TC Sensor Reading	Abs. Temp. Difference
Ice/Water			
Ambient			

&lt;1.5

Checked By:

Ernest 12/5/16  
Personnel Sign/Date

# THERMOCOUPLE CALIBRATION



Date: 12/21/16

Ambient Temperature: 68 °F

Calibrator: GW

Thermocouple No.: SB-2

Barometric Pressure: 27.28 "Hg

Type of Calibration system used: Omega

Reference Point No. <sup>a</sup>	Reference Thermocouple Temperature °F °C	Thermocouple Potentiometer Temperature °F °C	Difference <sup>b</sup>
1	50 10.0	50	0
2	100 37.8	101	1
3	150 65.6	150	0
4	200 93.3	200	0
5	250 121.1	250	0
6	300 148.9	300	0
7	350 176.7	351	1
8	400 204.4	400	0
9	450 232.2	450	0
10	500 260.0	500	0
11	550 287.8	550	0
12	600 315.6	601	1
13	650 343.3	651	1
14	700 371.1	701	1
15	750 398.9	750	0
16	800 426.7	800	0
17	850 454.4	850	0

<sup>a</sup> Every 30°C (50°F) for each reference point

<sup>b</sup> [(Ref. Temp: °C + 273) - (Test Therm. Temp: °C +273)] / (Ref. Temp. °C + 273) x 100 < 1.5%

# SAMPLE TRAIN TEMPERATURE CALIBRATION DATA DIAL THERMOMETERS



Ref. No. SP-2

Standard: Glass Thermometer ✓

Date Dec

## PRE-TEST

Thermometer	Boiling Water	Ambient	Acceptable Range + / - 2°F
Impinger (Yellow)	_____	_____	
Impinger (Gray)	_____	_____	

Date 12/21/16

## POST-TEST

Thermometer	Boiling Water	Ambient	Acceptable Range + / - 2°F
Impinger (Yellow)	_____	_____	
Impinger (Gray)	<u>204</u>	<u>68</u>	



## TYPE S PITOT TUBE INSPECTION DATA FORM

Pitot Number 1068065

Pre-sampling		Post-sampling
10/13/16	Date:	12/21/16
yes	Level?	yes
no	Obstructions?	no
no	Damaged?	no
0	$-10^\circ < \alpha_1 < 10^\circ$	0
0	$-10^\circ < \alpha_2 < 10^\circ$	0
0	$-5^\circ < \beta_1 < 5^\circ$	0
0	$-5^\circ < \beta_2 < 5^\circ$	0
0	$z \leq 1/8"$	0
0	$w \leq 1/32"$	0
.5	$1.05 D_t < P_a < 1.5 D_t$	.5
.5	$1.05 D_t < P_b < 1.5 D_t$	.5
.375	$3/16" < D_t < 3/8"$	.375
✓	$P_a = P_b \pm 0.063"$	✓

Comments: \_\_\_\_\_

This pitot tube meets or exceeds all specification criteria and/or applicable design features and is hereby assigned a pitot tube calibration of 0.84

Signature H. E. W.

## BAROMETER CALIBRATION

DATE	Hg BAROMETER READING	ANEROID BAROMETER	DIFFERENCE
1/9/15	27.36	27.36	0.0
2/6/15	27.47	27.47	0.0
2/19/15	27.33	27.33	0.0
3/5/15	27.34	27.33	0.1
3/9/15	27.34	27.34	0.00
3/12/15	27.24	27.25	0.01
4/10/15	27.33	27.34	0.01
4/27/15	27.24	27.25	0.0
5/10/15	27.24	27.24	0.02
6/3/15	27.23	27.25	0.01
6/17/15	27.24	27.25	0.01
7/2/15	27.24	27.25	0.02
7/21/15	27.36	27.38	0.02
8/22/15	27.25	27.27	0.02
9/29/15	27.34	27.40	0.06
10/14/15	27.36	27.42	0.06
10/29/15	27.24	27.28	0.04
11/19/15	27.31	27.30	0.01
12/11/16	27.47	27.48	0.01
01/14/16	27.27	27.26	0.01
02/25/16	27.38	27.37	0.01
03/18/16	27.22	27.28	0.06
03/28/16	27.17	27.19	0.02
4/14/16	27.19	27.21	0.02
4/25/16	27.16	27.19	0.03
5/7/16	27.22	27.20	0.02
5/11/16	27.24	27.23	0.01
5/22/16	27.23	27.23	0.0
5/27/16	27.23	27.25	0.02
6/16/16	27.11	27.15	0.04
7/17/16	27.33	27.38	0.05
7/19/16	27.34	27.36	0.02
8/19/16	27.26	27.27	0.001
10/14/16	27.26	27.25	0.01
10/20/16	27.34	27.35	0.01
11/28/16	27.30	27.28	0.02
12/21/16	27.28	27.28	0.00

EEMCFILES/ReportResources/Forms:Revised 08/24/12 jll



## NOZZLE CALIBRATION

Nozzle ID Number	Nominal Size, Inches	Measured	Average	Date / Initials
10 A	.2860	BROKE		12/21/16 G.W
10 B	.2820	.2821 .2822 .2819	.2820	12/21/16 G.W

Comments:

Nozzles measured by Precise Starrett expanding micrometer and micro-calipers.

WorldDrive01:\Forms\Forms\NozzleCalibrationForm.xls  
Revised 07/13/07 jmf

The 1440D provides a rack or panel mounted measurement of one or two of the following gases: oxygen, carbon dioxide, carbon monoxide and methane.



- Excellent stability and performance
- Low maintenance - no chemical cells to replace or renew
- Variants suitable for flammable/toxic sample gases
- Rack mounting or bench-top configuration.
- Concentration and low flow alarms.

Specification							
Gas Measured:	Oxygen	Methane	Carbon Dioxide	Carbon Monoxide			
<b>PERFORMANCE</b>							
Technology: Range:	Paramagnetic transducer 0 - 5, 10, 20, 25, 50, 100%	Infrared transducer 0 - 5, 25, 50, 100%	Infrared transducer 0 - 0.25, 0.5, 1.0, 2.5, 5, 10, 25, 50, 100%	Infrared transducer 0 - 1, 2.5, 10, 25, 50%			
Accuracy: (Intrinsic Error)	±0.1% O <sub>2</sub>	±1% of full scale	±1% of full scale	±1% of full scale			
Linearity: Repeatability: Response time (T <sub>90</sub> )	±0.1% O <sub>2</sub> ±0.1% O <sub>2</sub> <10 seconds	±1% of full scale ±1% of full scale <10 seconds	±1% of full scale ±1% of full scale <10 seconds	±1% of full scale ±1% of full scale <10 seconds			
Zero Drift: Span Drift:	<±0.002% O <sub>2</sub> /hour <±0.002% O <sub>2</sub> /hour	2% of full scale/week 1% of reading/day	2% of full scale/week 1% of reading/day	2% of full scale/week 1% of reading/day			
<b>SIGNAL OUTPUTS</b>							
Display: Display Resolution: Analogue Output:	3½ Digit LED 0.1%	One isolated 4-20mA output (maximum load impedance 600 ohms) and one non-isolated 0-1V output (typical output impedance 470 ohms) per transducer with full zero and span adjustment. The user may assign a second range to each output (Methane/Carbon Dioxide/Carbon Monoxide only, 80% of full scale). Two changeover relay contacts rated 1A/110VAC or 1A/28VDC non-inductive per measurement					
Alarms:							
<b>PHYSICAL</b>							
Dimensions (W x D x H):	Single unit: 236 x 380 x 178mm (9 x 15 x 7")	Double unit: 483 x 380 x 178mm (19 x 15 x 7")					
Weight:	Single unit: 5.5kg (12lb) typical,	Double unit: 12kg (26lb) typical					
Case Rating:	IP20 (IEC 529)						

<sup>1</sup> Two ranges are user selectable from those shown

## Power Supply

88 to 264VAC, 47 to 63Hz (45VA maximum)

## Ambient Conditions

Temperature:

Storage: -20 to +70°C (-4 to +158°F)  
Operating: 0 to 45°C (32 to 113°F)\*

Relative Humidity:

0 to 90% non-condensing

Pressure:

Oxygen measurement: 80 to 110 kPaa (0.8 to 1.1 bara)  
Carbon Dioxide/Carbon Monoxide/Methane: 90 to 110 kPaa (0.9 to 1.1 bara)

\* reduces in benchtop case to 0 to 40°C (32 to 104°F)

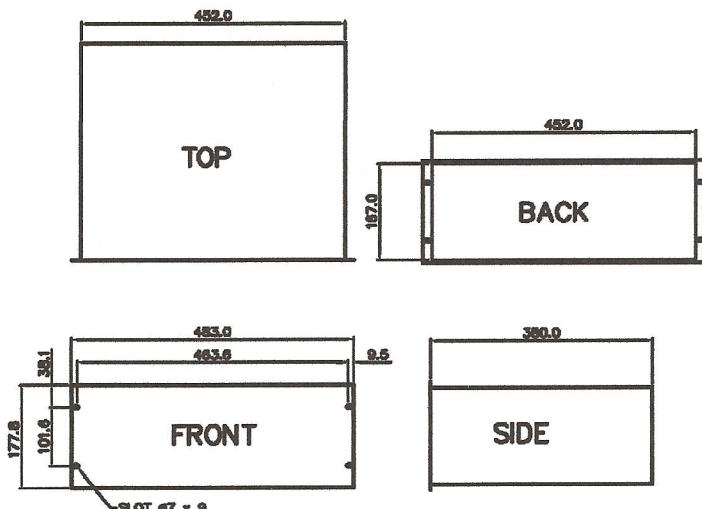
Warm up time:

Typically 1 hour

## Sample Gas Conditions

	Standard Analyser (STD)	Standard Analyser with back pressure regulator	Flammable/Toxic sample Analyser (FTX)
Inlet/Outlet Connections	6.4mm (1/4") OD tube DO NOT RESTRICT ANALYSER VENT		3.2mm (1/8") OD tube DO NOT RESTRICT ANALYSER VENT
Inlet Pressure	1 to 10 psig 7 to 70 kPag	17 to 20 psia 120 to 140 kPaa	Typically 0.3kpag (30 mmWG) at 200ml/min
Vent Pressure		11.6 to 15.9 psia 80 to 110 kPaa	13.0 to 15.9 psia 90 to 110 kPaa
Flow Rate	1 to 6 l/min	1 to 2 l/min	User limited to 250ml/min MAXIMUM
Dew Point	At least 5°C below ambient temperature		At least 5°C below ambient temperature
Temperature	Nominally at ambient temperature		Nominally at ambient temperature
Particulates	<3µm. an internal replaceable, 0.3µm filter is fitted as standard		An external filter of 6µm must be provided by the user
Condition	Clean, non flammable, non toxic*, non corrosive, oil free, dry (see dew point above)		Clean, non-corrosive, oil free, dry (see dew point above), toxic and flammable, but not oxygen enriched samples. The auto-ignition temperature of each flammable gas in the sample must be greater than 200°C.

\* For flammable or toxic samples use the 1440FTX

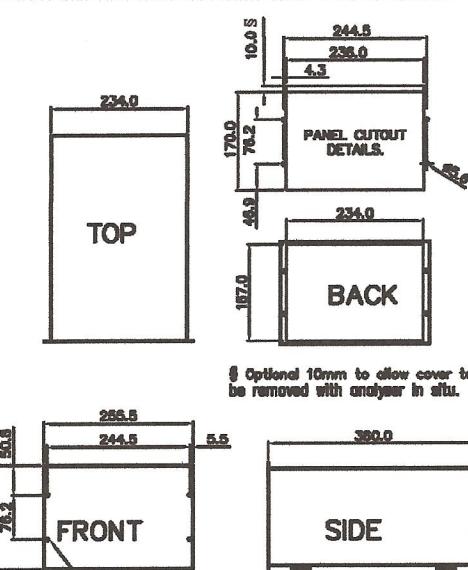


**A) DOUBLE UNIT CASE (NOT PANEL MOUNTABLE)**

Dimensions do not include Back Pressure Regulator if fitted an additional 110mm must be added to the back of the unit depth

## Sample Wetted Materials

Item	Materials
FTX analyser oxygen transducer	Stainless steel, Viton, borosilicate glass, platinum and nickel
FTX analyser methane/ carbon monoxide/ carbon dioxide transducer	Stainless steel, Viton, sapphire, epoxy resin
Additional materials with STD analyser	Bonded glass fibre, nylon, neoprene, gold on silver, brass, monel, acetylene, polypropylene
Additional materials with Back Pressure Regulator	Copper, PVC, PVDF, beryllium copper



**B) SINGLE UNIT CASE (PANEL MOUNTABLE)**

## EC Directive Compliance

The 1440 complies with the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC (as amended by Directive 92/31/EEC), both as amended by Directive 93/68/EEC.

It conforms to the following harmonised European standards for product safety and electromagnetic compatibility:

EN 50081-1: Generic emission standard

EN 50082-1: Generic immunity standard

EN 61010-1: Safety requirements for electrical equipment for measurement, control and laboratory use.

This product is rated for Installation Category II in accordance with IEC 664.

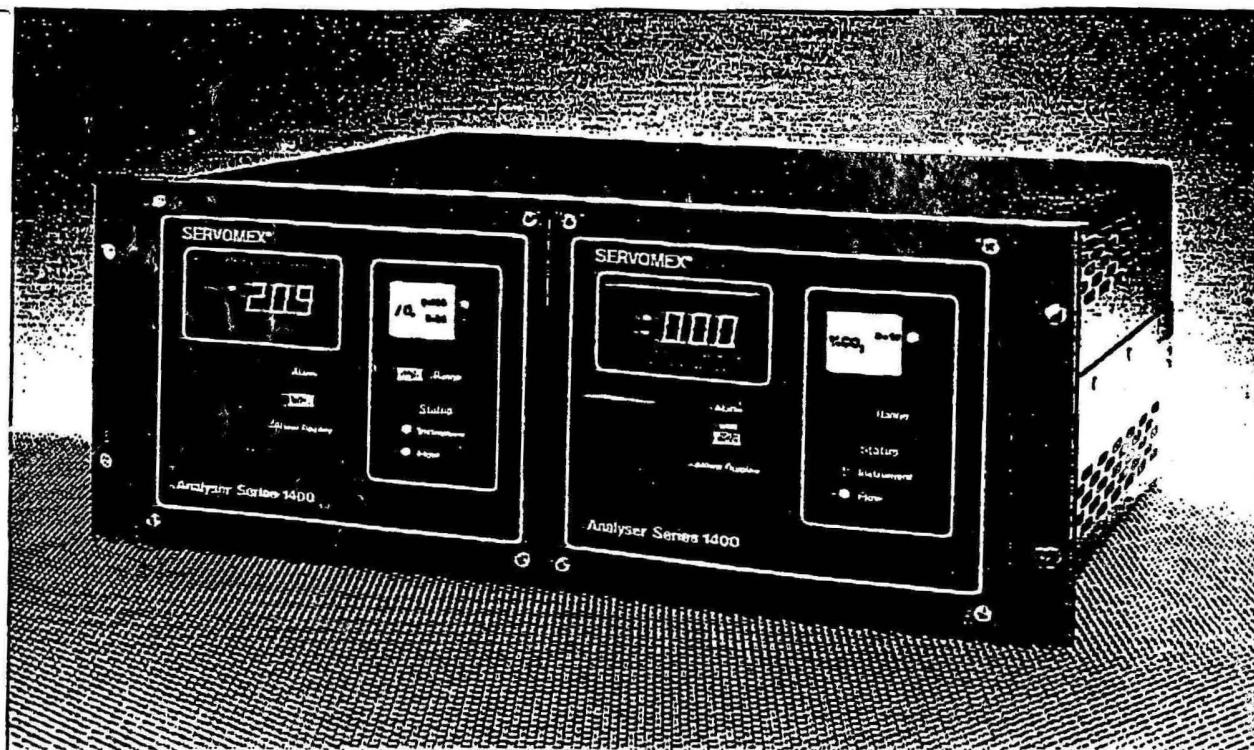
This product is rated for Pollution Degree 2 in accordance with IEC 664.

### Performance Specification Continued

Gas Measured	Oxygen	Methane	Carbon Dioxide	Carbon Monoxide
Output fluctuation (peak to peak noise):	±0.02%O <sub>2</sub>	0.5% of selected range	0.5% of selected range	0.5% of selected range
Ambient temperature coefficient:	<±0.05% O <sub>2</sub> /10°C zero <±0.3% reading/10°C span	1% of full scale per 10°C change	1% of full scale per 10°C change	1% of full scale per 10°C change
Ambient pressure coefficient: (with back pressure regulation, only available for STD analyser):	Directly proportional (0.025% reading per mbar)	0.15% of reading per mbar within specified range (0.025% reading per mbar)	0.15% of reading per mbar within specified range (0.025% reading per mbar)	0.15% of reading per mbar within specified range (0.025% reading per mbar)
Sample flow effect:	0.1% of O <sub>2</sub> for 50 to 200ml/min	3% of full scale for 50 to 200ml/min	3% of full scale for 50 to 200ml/min	3% of full scale 50 to 200ml/min

The performance specification has been written, and verified, in accordance with the international standard IEC 1207-1: 1994 "Expression of performance of gas analysers"

**SERVOMEX 1400B  
LIGHT INDUSTRIAL  
GAS ANALYSER**



**FEATURES**

- Paramagnetic Oxygen and Infrared Transducers
- 19" Rack, Panel Mount and Bench-Top Cases
- Voltage and Current Outputs

**BENEFITS**

- Suitable for a wide range of applications
- Meets User's configuration requirements
- Interfaces with the user's data recording device

**Introduction to 1400B Series**

The Servomex 1400B Series meets the light industrial market's requirement for a moderately priced, high performance, general purpose analyser.

Servomex offers the 1400B in three user selected case configurations: 19" rack mounting, panel mounting and bench-top. The above picture shows a dual unit 1400B in a 19" rack mounting case.

The 1400B Series features high visibility LED displays, dual linear electrical outputs: 0-1VDC

non-isolated, and 4-20mA isolated, dual concentration alarms and (for non flammable samples) flow alarm all as standard.

A back pressure regulator option is available on standard 1400B analysers to reduce the effects of barometric or sample vent pressure changes when the 1400B is used for measuring high concentrations of oxygen or other gases.

The 1400B Series now offers three types of transducers, each meeting a requirement of the light industrial market:

Parameter	Conditions / Comments	O <sub>2</sub> FLS	O <sub>2</sub> STD	CO <sub>2</sub> STD	SPX	SPX
<b>Environmental</b>						
Operating Ambient Temperature	a) Single or dual case b) Fitted into bench-top case		0-45°C (32-113°F) 0-40°C (32-104°F)		0-40°C (32-104°F) 0-35°C (32-95°F)	
Sensor / Transducer Temperature	nominal control temperature		50°C	60°C		
Storage Temperature			-20°C to +70°C (-4°F to 158°F)			
Relative Humidity			0-90% non-condensing		5 to 85% non-condensing	
AC Power Supply		88-264V 47-63Hz, 45VA max.			120 or 240VAC±10% 48 to 62Hz 30mA max	
EMC	Designed for compliance with:		EN 50022 (1987) CLASS A for conducted interference and radiated electric field			
Vibration			Protect from excessive vibration			
<b>Sample Requirements</b>						
Condition			Clean, dry gas with dew point at least 5°C below ambient temperature non-toxic, non-flammable			
Inlet Pressure / Flow Rate	Refer to flow schematics overleaf:	See schematic a	See schematics b & c		See schematic d	
Flammable Gases	ISA-S12.12 (1984) BS5345, Part 1 (1976)	groups B,C,D T3 group IIC, T3		Not Applicable Not Applicable		groups C and D, T4 groups IIIA and IIIB, T4
Filtering	SPX & FLS require external 0.6 micron filter		0.6 micron replaceable		0.6 micron	
Gas Connection	located at the rear of the unit	3.2mm(1/8")OD stub	8.4mm (1/4 inch) O.D. tube stub suitable for 1/4 inch compression fittings			
<b>Physical Characteristics</b>						
Case	a) Description b) Classification		Steel and aluminium, finished in epoxy powder paint (IP20 IEC 628) when fitted in the 19 inch rack case			
Overall Dimensions	a) Double case 4U b) Single case 4U c) Bench-top case d) Back pressure option		178mm high x 483mm wide x 380mm deep 182mm high x 256mm wide x 420mm deep 228mm high x 520mm wide x 400mm deep depth becomes 460mm approx.			
Weight	single unit double unit bench unit		5.5kg (12lb) typical 12kg (26lb) typical 20kg (44lb) typical			
Unit Identification	Rear panel serial no....	1421B NNN	1420B NNN	1415B NNN	1410B NNN	1411B NNN
	The Company reserves the right to alter the specification without prior notice.					

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**Listing of Quality Control Procedures  
EPA 1-4, 5 and 17 Testing Methodology  
Gas Stream Characteristics/Particulates**

**I. Calibration of Equipment**

A. Meter box (meter)

The meter box is calibrated with a critical orifice prior to and after the test series. In addition, the initial test includes a profile covering pertinent delta H values. The post meter box calibration includes a triplicate calibration at the meter delta H or the average delta H experienced during the test series.

B. Thermometers or Thermocouples

- 1) Dry gas meter (DGM) (2)
- 2) Silica gel impinger effluent (1)

These are checked at ambient and boiling water conditions prior to and after the test series. If they are off more than +/- 5.4 °F for the DGM or collection box or +/- 2.0 °F for the impinger, they are adjusted or replaced (if not correctable). In addition, in the field all thermometers or thermocouples are daily checked prior to sampling utilizing ambient temperatures (reference glass thermometers and/or an Omega Simulator (thermocouple)).

3) Stack Gas

The temperature sensor system is compared to standard glass thermometers in solutions of water and/or oil. An Omega thermocouple simulator (Calibrator CL-30) is utilized for high temperature thermocouple calibration performance.

C. Manometer (vertical/inclined)

This device is a primary standard. It is leak checked prior to and during field utilization. During use it is operated at level conditions.

D. Vacuum Gauge

The vacuum gauge is an indicator of train vacuum - it does not affect the sample. Performance is checked each time the unit is utilized. If it is suspect, it is discarded and replaced.

E. Meter Box Leak Integrity

The meter box is placed under positive pressure just prior to field testing to determine if a leak exists. This procedure is repeated prior to each meter calibration.

F. Impinger Weight

The Greenberg/Smith impingers are weighed in the field utilizing an Ohaus Balance. A set of Ohaus standard weights are used to ensure field accuracy.

G. Orsat/Fyrite Gas Analyzer (CO<sub>2</sub> & O<sub>2</sub>)

The orsat analyzer is rebuilt after each test series. The scrubber flasks are removed and cleaned. The solutions are replaced and the unit is leak checked. Instrumentation is leaked checked and pre and post calibrated. In the field, the unit is checked again for leaks prior to use.

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## I. Calibration of Equipment - (continued)

### H. Gas Flow

An S-type pitot is used for measurement of stack gas dynamic and static pressure. The geometry of the pitot head is measured to ensure compatibility with EPA specifications at 0.84 pitot coefficient.

### I. Barometer (aneroid)

A mercury wall barometer is utilized to determine and set the aneroid prior to field testing. It is rechecked after the test series.

### J. Nozzle Diameter

Precise Starrett expanding micrometer and micro-calipers are utilized for at least a triplicate determination of nozzle diameter.

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## II. Sampling

### A. Sampling train

A pre and post leak check of the sampling train is conducted for each test.

### B. Gas Flow

A pitot system leak check is conducted prior to and after the test series.

### C. Temperature (Thermocouple)

An electronic simulator is utilized for field determination of response accuracy at the stack temperature measurement.

### D. Temperature

Dial - Train thermometers and/or thermocouples are checked against ambient air to determine continued field integrity.

### E. Orsat/Fyrite

Ambient air is analyzed in the field to assess orsat/fyrite performance.

### F. Impinger balance

The balance is zeroed and checked for accuracy with standard weights.

### G. Probe cleaning

After probe wash/clean out the probe is visually inspected.

### H. Sample Removal

The samples are placed into glass or inert plastic bottles for removal to the laboratory.

Labeling includes (as a minimum):

- a) Date
- b) Run #
- c) Liquid Level mark
- d) Sample description
- e) Source I.D.

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## III. Post Sampling

Samples are washed from each train component three times utilizing the specified wash material. The resultant captures are removed to EEMC's laboratory for analysis.

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## **IV. Laboratory Analysis**

### **A. Particulates**

The laboratory balance is calibrated (with S weights) just prior to each act of weighing. Standard interim weights are utilized to determine if the calibration has been successful (+/- 0.5 mg).

### **B. Sample Weighing**

#### **1) Filters (initial - tare)**

The desiccated filters are tared to a constant weight (+/- 0.5 mg).

#### **2) Wash - beakers - tare**

Beakers or weighing dishes are tared to a constant weight (+/- 0.5 mg).

#### **3) Filters (final - sample)**

Each desiccated sample filter is weighed until a final constant weight (requires at least two weighings) is achieved. A blank filter is also weighed in the same manner.

#### **4) Wash/Beakers (250 ml) or weighing dishes - sample**

Each desiccated beaker is re-weighed until a constant weight is achieved. Blank acetone or other diluent wash containers are weighed concurrently with the sample filter. In order to ensure a representative wash blank, the wash and blank solutions are brought up to a common volume (normally 200 ml). Acetone or other diluents residues would thus be at a common volume.

This document is not designed to be a redundant dissertation of EPA methods. Instead, it is a brief commentary on general practices as routinely employed, almost all of which are described in EPA reference methods and quality control manuals.

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## **Listing of Quality Control Procedures for EPA Methods 3A and 7E Testing Methodology**

### **I. Calibration of Equipment (NO<sub>x</sub> in N<sub>2</sub> or Air)**

- A) Zero and Span
  - EPA Protocol 1 calibration gases are utilized for instrument zero/span purposes. The filtered air or N<sub>2</sub> tank is utilized for zero purposes. The concentration of these gases is determined as per EPA Method 7E, Section 7.1.
- B) Chemiluminescent instrumentation or equivalent is utilized for NO<sub>x</sub> concentration determination. Converter efficiency is determined utilizing tank gas containing NO<sub>2</sub> as per Method 7E. Interferences have been determined (by the vendors) to meet selectivity requirements.
- C) All calibrations must be drawn through the sample interface. All instruments are checked for linearity via EPA Protocol 1 gases before each test series (zero and two calibration gas concentrations).
- D) Sample Moisture
  - Moisture removal is via a thermoelectric cooler at the head of the interface, and in the case of heavy moisture, additionally at the terminal end of the interface prior to injection to the instruments.

### **II. Sampling (NO<sub>x</sub>)**

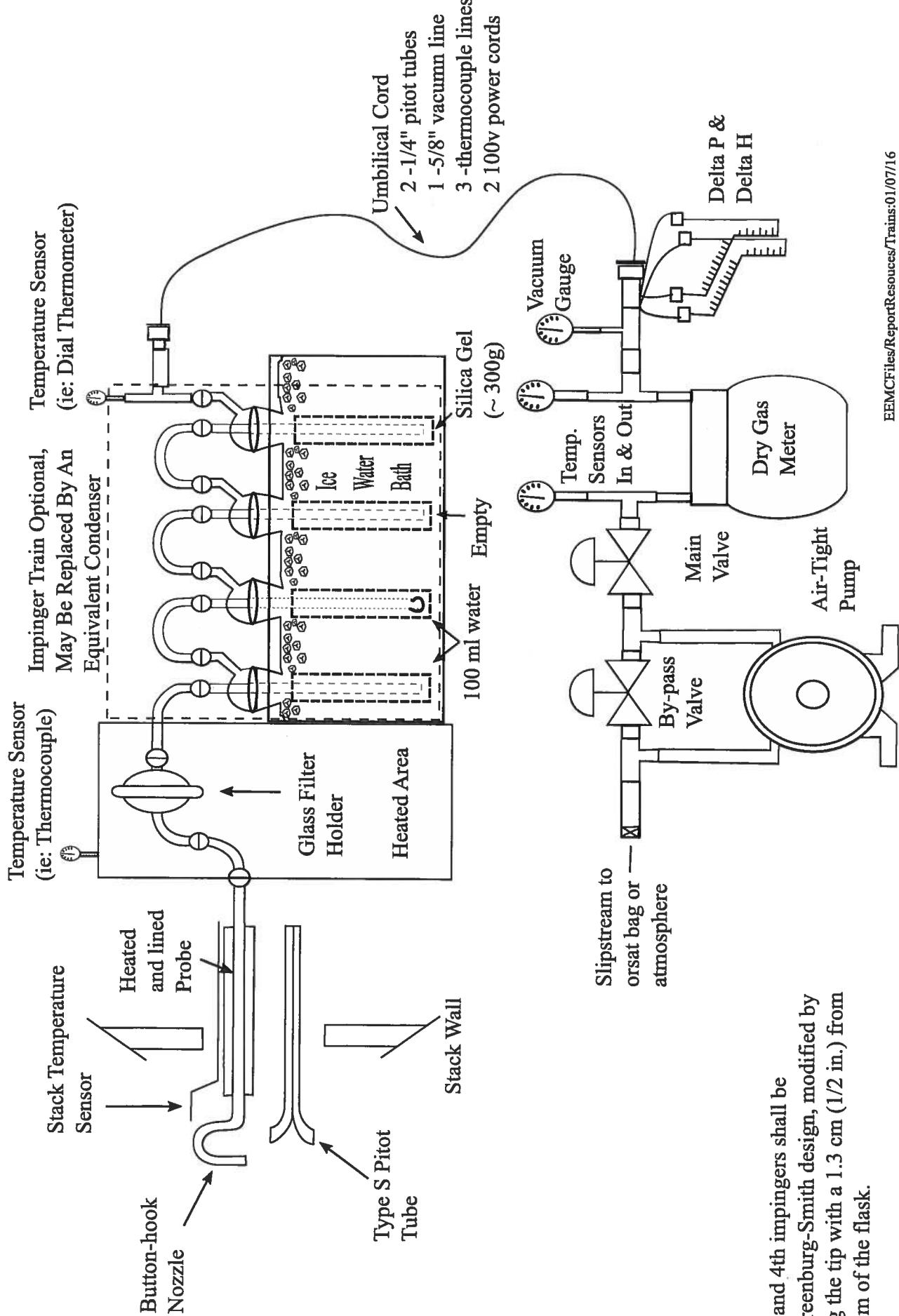
- A) The results are recorded on an integrating computer/logger on a minute by minute basis.
- B) Sample Interface
  - The interface is leak checked prior to and after each sampling session.

### **III. Oxygen/Carbon dioxide (O<sub>2</sub>/CO<sub>2</sub>) Instrumentation**

- A) Zero and Span
  - EPA Protocol 1 is utilized for calibration of the O<sub>2</sub>/CO<sub>2</sub> instrumentation as per Method 3A.
- B) A Servomex 1400B O<sub>2</sub>/CO<sub>2</sub> Analyzer is utilized.
- C) The results are recorded on an integrating computer/logger on a minute by minute basis.

## EPA Method 5

### Example Particulate Sampling Train



# EPA Methods 1-5

## 40CFR60 App. A



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### Title 40 Protection of Environment

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Part 60 (Appendices)

Containing a codification of documents  
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